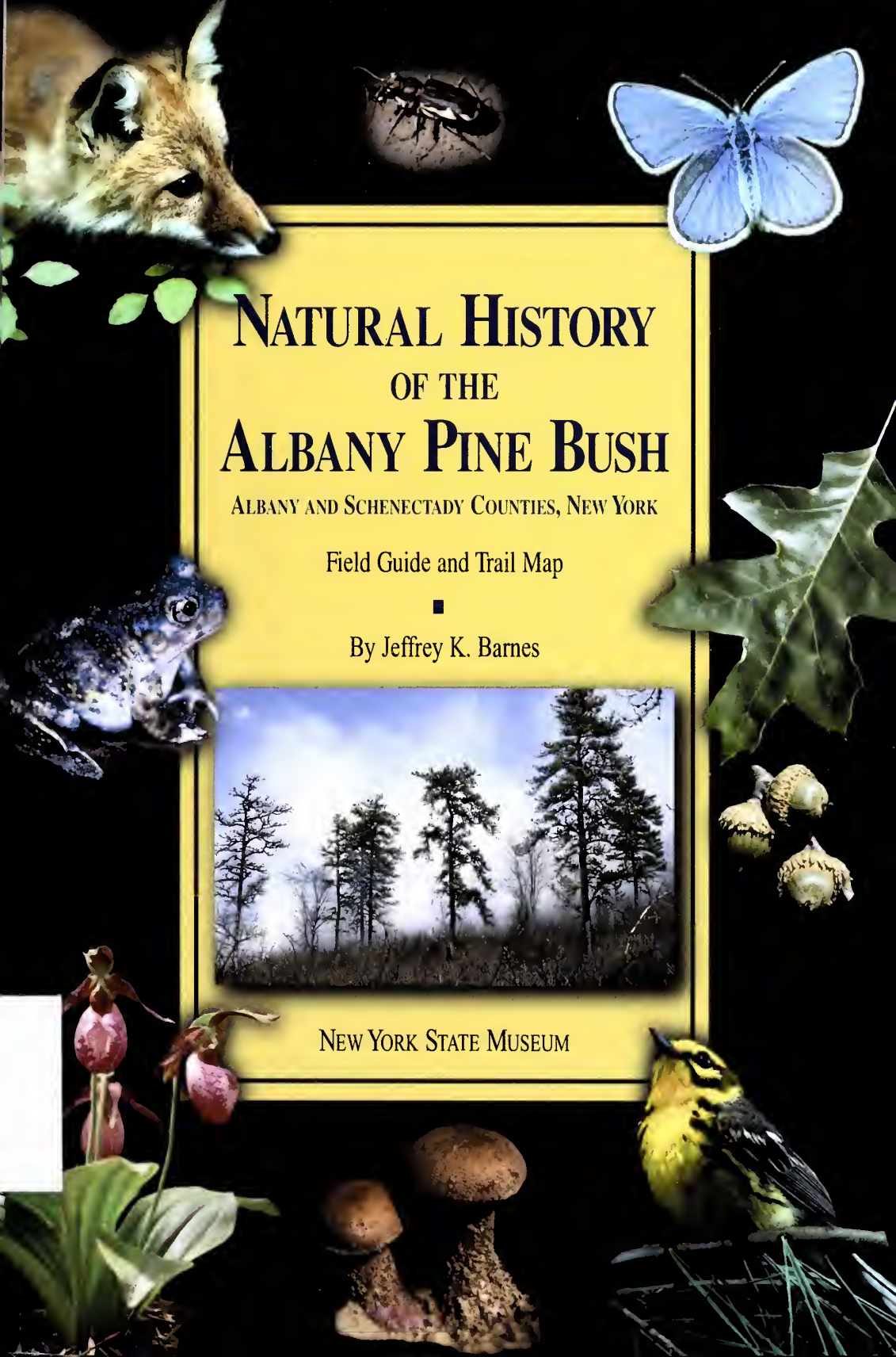


# Natural History of the Albany Pine Bush

Albany and Schenectady Counties, New York

Field Guide and Trail Map

By Jeffrey K. Barnes



New York State Museum

Digitized by the Internet Archive
in 2017 with funding from
IMLS LG-70-15-0138-15

https://archive.org/details/naturalhistoryof5022barn

# Natural History of the Albany Pine Bush:

## Albany and Schenectady Counties, New York

Including a Field Guide and Trail Map

# THE UNIVERSITY OF THE STATE OF NEW YORK

## Regents of The University

| | |
|---|---|
| Robert M. Bennett, *Chancellor,* B.A., M.S. | Tonawanda |
| Adelaide L. Sanford, *Vice Chancellor,* B.A., M.A., P.D. | Hollis |
| Diane O'Neill McGivern, B.S.N., M.A., Ph.D. | Staten Island |
| Saul B. Cohen, B.A., M.A., Ph.D. | New Rochelle |
| James C. Dawson, A.A., B.A., M.S., Ph.D. | Peru |
| Robert M. Johnson, B.S., J.D. | Huntington |
| Anthony S. Bottar, B.A., J.D. | North Syracuse |
| Merryl H. Tisch, B.A., M.A. | New York |
| Geraldine D. Chapey, B.A., M.A., Ed.D. | Belle Harbor |
| Arnold B. Gardner, B.A., LL.B. | Buffalo |
| Harry Phillips, 3rd, B.A., M.S.F.S. | Hartsdale |
| Joseph E. Bowman, Jr., B.A., M.L.S., M.A., M.Ed., Ed.D | Albany |
| Lorraine A. Cortés-Vázquez, B.A., M.P.A. | Bronx |
| Judith O. Rubin, A.B. | New York |
| James R. Tallon, Jr., B.A., M.A. | Binghamton |
| Milton L. Cofield, B.S., M.B.A., Ph.D. | Rochester |

**President of The University and Commissioner of Education**
Richard P. Mills

**Chief Operating Officer**
Richard H. Cate

**Director of the New York State Museum**
Clifford A. Siegfried

The State Education Department does not discriminate on the basis of age, color, religion, creed, disability, marital status, veteran status, national origin, race, gender, genetic predisposition or carrier status, or sexual orientation in its educational programs, services and activities. Portions of this publication can be made available in a variety of formats, including braille, large print or audio tape, upon request. Inquiries concerning this policy of nondiscrimination should be directed to the Department's Office for Diversity, Ethics, and Access, Room 530, Education Building, Albany, NY 12234. **Requests for additional copies of this publication may be made by contacting Publication Sales, Room 3140, Cultural Education Center, Albany, NY 12230.**

# Natural History of the Albany Pine Bush:

# Albany and Schenectady Counties, New York

**Including a Field Guide and Trail Map**

by Jeffrey K. Barnes

*sponsored by*
New York State Biodiversity Research Institute

**New York State Museum Bulletin 502**
**2003**

New York State Museum
The University of the State of New York
The State Education Department

Copyright © 2003 The New York State Education Department

Printed in the United States of America

Copies may be ordered from:
**Publication Sales**
**3140 CEC**
**New York State Museum**
**Albany, New York 12230**
**518/502-5344**
**518/474-2033 (fax)**
**www.nysm.nysed.gov/publications.html**

Library of Congress Catalog Card Number: 2003105391

ISSN: 0278-3355

ISBN: 1-55557-146-8

## Acknowledgment

The New York State Museum gratefully acknowledges the substantial financial contribution of the New York State Biodiversity Research Institute.

MERTZ LIBRARY
NEW YORK
BOTANICAL
GARDEN

# Contents

**Preface** ..... xi

**Acknowledgments** ..... xiii

**Natural History of the Albany Pine Bush: Geology, Ecology, and Biology** ..... 1

**Introduction** ..... 3
- Northeastern Pine Barrens ..... 3
- New York Pine Barrens ..... 4

**The Albany Pine Bush** ..... 5

**Geological History** ..... 10

**Postglacial Biotic Development** ..... 13

**Climate and Seasonality** ..... 15

**Soil and Water** ..... 15

**Fire Ecology** ..... 18

**Fire History** ..... 21

**Fire Suppression** ..... 24

**Human Disturbance** ..... 25

**Modern Ecological Communities** ..... 28
- Terrestrial Communities ..... 29
  - Pitch Pine–Scrub Oak Barrens ..... 29
  - Pitch Pine–Oak Forest ..... 30
  - Appalachian Oak–Pine Forest ..... 31
  - Pine–Northern Hardwood Forest ..... 31
  - Successional Northern Hardwood Forest ..... 31
  - Successional Southern Hardwood Forest ..... 32
- Palustrine Communities ..... 32
  - Pine Barrens Vernal Pond ..... 32
  - Rich Sloping Fen ..... 32
  - Shallow Emergent Marsh ..... 33
  - Red Maple–Hardwood Swamp ..... 33
- Artificial Terrestrial Communities ..... 33

**Modern Biota** ..... 34
- Fungi ..... 34
- Lichens and Bryophytes ..... 35
  - The Pine Bush Bryophyte Flora, by N. G. Miller and L. Leonardi ..... 35
- Vascular Plants ..... 36
- Insects and Other Arthropods ..... 40
- Amphibians and Reptiles ..... 45
- Birds ..... 46
- Mammals ..... 48

**Human History in the Albany Pine Bush: Exploitation, Conservation, and Management** ..... 51

**Exploitation** ..... 53
Hunting, Farming, and Settlement ..... 53
Trade Routes and Transportation Corridor ..... 54
Timber Resources ..... 56
Sand Resources ..... 57
Water Resources ..... 58
Residential, Commercial, and Industrial Development ..... 58

**Conservation** ..... 58

**Protection and Management** ..... 62
Habitat Loss, Fragmentation, and Protection ..... 62
Wetland and Aquifer Degradation ..... 64
Fire Suppression and Vegetation Management ..... 65
The Role of Fire in the Albany Pine Bush, by C. A. Hawver ..... 68
Alternative Management Techniques, by J. Hecht ..... 70
Invasive and Nonnative Species ..... 72
Loss of Native Species ..... 73
Karner Blue Butterfly, by N. A. Gifford ..... 74
Recreation and Education ..... 75
Recreation and Educational Opportunities in the Albany Pine Bush, by E. M. Kinal ..... 76

**Species Synopses** ..... 79

**Fungi, Mosses, and Ferns** ..... 81
Sandy Laccaria ..... 81
Barometer Earthstar ..... 81
Common Hair-cap Moss ..... 82
Juniper Moss ..... 82
Awned Hair-cap Moss ..... 83
Bracken ..... 83

**Trees** ..... 85
Tamarack, American Larch ..... 85
Pitch Pine ..... 85
Scarlet Oak ..... 87
Red Oak ..... 88
Black Oak ..... 89
Basswood ..... 89
Big-toothed Aspen ..... 90
Quaking Aspen ..... 91
Fire-cherry, Pin-cherry ..... 92
Black Cherry ..... 92
Black Locust ..... 93
Red Maple ..... 94

**Shrubs** ..... 95
Sweet-fern ..... 95
Scrub Oak, Bear Oak ..... 95
Dwarf Chestnut Oak ..... 96
Hazelnut ..... 97
Dune Willow ..... 98

Leatherleaf ..... 98
Black Huckleberry ..... 99
Sheep Laurel ..... 99
Highbush Blueberry ..... 100
Hillside Blueberry, Low Blueberry ..... 101
Black Chokeberry ..... 102
Sand-cherry, Eastern Dwarf Cherry ..... 102
Meadow-sweet ..... 103
Hardhack, Steeplebush ..... 103
Gray Dogwood ..... 104
New Jersey Tea ..... 104
Smooth Sumac ..... 105
Bush Honeysuckle ..... 106

**Sedges and Grasses** ..... 107
Pennsylvania Sedge ..... 107
Tussock Sedge, Hummock Sedge ..... 107
Big Bluestem ..... 108
Little Bluestem ..... 109
Indian Grass ..... 110

**Wildflowers** ..... 111
Wild Columbine ..... 111
Rue Anemone ..... 111
Winged Pigweed ..... 112
Frostweed ..... 112
Bird's-foot Violet ..... 113
Whorled Loosestrife ..... 113
Giant Tick-clover ..... 114
Round-headed Bush Clover ..... 114
Wild Lupine ..... 115
Goat's Rue ..... 116
Bastard-toadflax ..... 117
Rose Milkwort ..... 117
Spreading Dogbane ..... 118
Blunt-leaf Milkweed ..... 118
Butterfly-weed ..... 119
Wild Bergamot ..... 119
Dotted Horsemint ..... 120
Pearly Everlasting ..... 120
Late Purple Aster ..... 121
Spotted Knapweed, Bushy Knapweed ..... 122
Woodland Sunflower ..... 123
Early Goldenrod ..... 123
Wood Lily ..... 124
False Solomon's Seal ..... 125
Starry False Solomon's Seal, Starflower ..... 125
Strawbell ..... 126
Pink Ladyslipper ..... 126

**Insects and Arachnids** ..... 127
Deer Tick ..... 127
Lintner's Bog Skimmer ..... 128
Antlion ..... 128
Tiger Beetle ..... 129
Pine Needle Miner ..... 130

Dusted Skipper ..... 130
Silver-spotted Skipper ..... 131
Dreamy Dusky Wing ..... 132
Juvenal's Dusky Wing ..... 132
Frosted Elfin ..... 133
Karner Blue Butterfly ..... 134
American Copper ..... 135
Edward's Hairstreak ..... 136
Inland Barrens Buck Moth ..... 137
Gall Wasps ..... 138
Allegheny Mound Ant ..... 138

**Amphibians and Reptiles** ..... 141
Mole Salamanders ..... 141
Fowler's Toad ..... 141
Eastern Spadefoot ..... 142
Spotted Turtle ..... 142
Wood Turtle ..... 143
Eastern Box Turtle ..... 143
Eastern Worm Snake ..... 144
Northern Black Racer ..... 145
Eastern Hognose Snake ..... 145
Northern Water Snake ..... 146

**Birds** ..... 147
Whip-poor-will ..... 147
Yellow-bellied Sapsucker ..... 147
Pileated Woodpecker ..... 148
Eastern Bluebird ..... 148
Brown Thrasher ..... 149
Golden-winged Warbler ..... 149
Nashville Warbler ..... 150
Chestnut-sided Warbler ..... 151
Pine Warbler ..... 151
Prairie Warbler ..... 152
Ovenbird ..... 153
Common Yellowthroat ..... 153
Eastern Towhee ..... 154
Field Sparrow ..... 154
Indigo Bunting ..... 155
Brown-headed Cowbird ..... 155

**Mammals** ..... 157
Masked Shrew ..... 157
Hairy-tailed Mole ..... 157
Eastern Chipmunk ..... 158
Woodland Jumping Mouse ..... 159
Southern Red-backed Vole ..... 159
White-footed Mouse ..... 160
Woodland Deer Mouse ..... 161
Coyote, by R. Kays and D. Bogan ..... 161
Red Fox ..... 163
Fisher, by R. Kays and D. Bogan ..... 164
Long-tailed Weasel ..... 165

**Appendix A:** Bryophytes Species List
by N. G. Miller and L. Leonardi ..... 169

**Appendix B:** Vascular Plants Species List
by G. R. Robinson and K. Moore ..... 173

**Appendix C:** Insects Species Lists ..... 201

**Appendix D:** Fishes Species List ..... 217

**Appendix E:** Amphibians and Reptiles Species List ..... 219

**Appendix F:** Birds Species List ..... 221

**Appendix G:** Mammals Species List ..... 231

**References Cited** ..... 235

# Preface

Anyone who has visited New York's Capital District for more that a few days has heard about Nabokov's "sandy and flowery little paradise," known as the Albany Pine Bush. It is the subject of unending news coverage and continuing conflict between those with environmental leanings and those with business interests in the land area between the cities of Albany and Schenectady. Unfortunately many area residents' accumulated lifetime knowledge of this amazing ecosystem consists of only a few hazy conceptions or misconceptions derived from television and newspaper stories. Their entire firsthand experience of the Pine Bush is derived from passing glimpses of pitch pines while speeding down New Karner Road or commuting on the Thruway between the Hudson and Mohawk, between Albany and Schenectady. Those who would take a more studied interest in Pine Bush plants and animals have been frustrated by lack of access to complete and reliable information.

While developing an exhibit on the Pine Bush for the New York State Museum in 1996, I faced the daunting task of rooting out accurate and interesting details with which to present the story of Pine Bush life. Thus was born the idea for this guide to the biology and ecology of the Pine Bush. It was only later that I found noted in the 1993 Albany Pine Bush Management Plan (Environmental Design and Research, P.C. 1993) that the general public often fails to appreciate the area's unique qualities because it lacks sufficient understanding of ecology. The authors of that plan found that more background information on pine barrens ecology, species adaptation, and natural forces would be useful. Likewise it is difficult to appreciate the area as a dynamic system without some knowledge of the geological and cultural histories that have helped to shape it. The authors of the Management Plan recommended that interpretive materials be developed revolving around a clearly focused core of ecological principles that includes local human influences.

This book began as a popular interpretation and field guide to the Pine Bush for those interested in strolling the area's many paths. It quickly became clear that the need for access to information is so great among scientists, land managers, developers, journalists, and the general population, that I was forced to reconsider the audience that I would serve. The result is a hybrid guide that interprets Pine Bush natural history for an audience of varied backgrounds and interests, synthesizes recent research, and provides access to the growing body of literature.

The importance of Don Rittner's *Pine Bush: Albany's Last Frontier* (1976) is in no way diminished. That book played a seminal role in swaying public opinion and sparking development of the Albany Pine Bush Preserve, and it is a monument to Don's untiring zeal. Don laid the foundation from which I have worked. However, his book is long out of print, and information presented therein is sorely in need of updating. It is my hope that the following pages will stimulate new generations of students, citizens, and scientists to appreciate the rare and globally imperiled Pine Bush natural ecosystem, and to keep it safe for all time as a wild and unspoiled oasis of biodiversity.

It has been difficult choosing species to highlight with pictures and synopses. I have endeavored to highlight species that are notable for some reason. Some, like the Karner blue butterfly, are imperiled throughout their range. The eastern box turtle and some snakes have presumably disappeared from the Pine Bush, but their historical occurrence and recent demise are part of the Pine Bush story, essential to understanding the present state of the ecosystem. Other species, such as the hognose snake, are uncommon in New York State, although they are rather common in other parts of their range. Still others, such as the woodland sunflower, are recurring and attractive themes in the Pine Bush, likely to be noticed by the casual visitor. Spotted knapweed and some other plants are worthy of note as invasive weedy or pest species. Many, but not all,

species found on these pages are members of the pitch pine–scrub oak community. They are likely to favor sandy, arid habitats, and some have special adaptations that allow them to survive fire. It is impossible to treat all of the thousands of interesting species that occur in the Albany Pine Bush. Perhaps I should have featured some other species not found in this volume. Fortunately we are blessed with a plethora of field guides to the northeastern plants and animals. The curious naturalist will find a visit to the local bookstore or library very rewarding.

The boundaries of the Pine Bush depend somewhat on definition. This unique environment of sand dunes and wetlands is located southwest of the confluence of the Mohawk and Hudson Rivers, south of the Adirondack Mountains and north of the Catskills, and it runs from Albany on the east to Schenectady on the west, mostly in Albany County, New York State. The Albany Pine Bush is in an area of primarily sandy soils that once formed the bed of Glacial Lake Albany. The ancient Mohawk River created a massive delta stretching from Schenectady to Albany by dumping sediment into Lake Albany. After the lake drained, thousands of years of wind action created dune fields and sand plains. For the purposes of this volume, these areas, and their associated plant and animal communities, are considered the Albany Pine Bush. Within this larger landscape, a nature preserve is being assembled from parcels of land purchased or otherwise protected for that purpose. It is located within a study area bounded on the north by New York Route 5, on the south by U.S. Route 20, on the east by Fuller Road, and on the west by New York Route 146. This area consists of a variety of residential, commercial, and industrial uses surrounding and interspersed with the more-or-less centrally located Preserve lands. This area is referred to in this volume as the Albany Pine Bush Preserve or simply the Preserve.

Jeffrey K. Barnes
The Arthropod Museum
University of Arkansas
Fayetteville, Arkansas
June 10, 2003

# Acknowledgments

The Albany Pine Bush Preserve Commission was instrumental in the development of the plan for this book. Stephanie Gifford and Chris Hawver met with me in January 1997 to hash out a plan for this volume. The Commission also opened its doors to me and allowed free access to reference materials that I would have been unable to see otherwise. Erin Kinal has been ever gracious and encouraging. This book would not have matured without the generous exchange of ideas and information provided by Chuck Sheviak and Tim McCabe of the New York State Museum. The value of this volume has been immeasurably enhanced by authoritative species lists generously provided by Norton Miller and Lorinda Leonardi of the New York State Museum (mosses and liverworts and hornworts), George Robinson of the University at Albany (vascular plants), and Tim McCabe of the New York State Museum (butterflies and moths). Kathy Schneider (New York State Heritage Program), Bob Budliger (Hudson-Mohawk Bird Club), and Brian Beachy (University at Albany) reviewed and improved the sections on birds; Roland Kays (New York State Museum) reviewed the section on mammals; Kimberley C. Hunsinger (New York State Department of Environmental Conservation) kept me honest about the amphibians and reptiles. George Robinson, Margaret Stewart (University at Albany), Robert Dirig (Cornell University), and the staff of the Albany Pine Bush Preserve Commission reviewed the original manuscript and made many suggestions that have immeasurably improved the value of this book. In composing many of the plant species synopses found here, I have made liberal use of the Fire Effects Information System (U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory 2000, http://www.fs.fed.us/database/feis/) and the North American silvics manual (Burns and Honkala 1990, http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm). I took most of the photographs under natural lighting conditions with a handheld 35 mm camera outfitted with a macrolens. Others who supplied photographs are acknowledged in the captions. Paul Meyers of Niskayuna graciously consented to allow the use of his outstanding photographs of Pine Bush mammals, reptiles, and amphibians. Major funding for this project is provided by the New York State Biodiversity Research Institute. Ronald Gill (New York State Biodiversity Research Institute) did an outstanding job of preparing the maps and guiding the manuscript through the review process. John B. Skiba (New York State Museum) managed publication production with professional skill and insight. The liberal folks at the Department of Entomology, University of Arkansas, are recognized for allowing me the time to complete this work, which I started while employed at the New York State Museum.

# Natural History of the Albany Pine Bush:

# Geology, Ecology, and Biology

# Introduction

A visit to the Albany Pine Bush is unlike any other urban experience in North America. By walking only a few feet from the car or office or home, we are transported to a landscape so unfamiliar to the Upstate New Yorker that we seem to be in a different era and a different place. The landscape is at once gaunt and beautiful. It feels bleak on cold and gray days, yet plants and animals spill from its undulating dunes and fill the air with delightful sights and sounds and smells with seasonal regularity. It seems remote and desolate, but the reminders of civilization never fully disappear. Awakening from the unconscious distraction of vivid blooms, buzzing insects, and warmth radiating from the fine, deep sands, the nature lover hears once more the rushing sound of surrounding vehicular traffic and the distant rumble of a train. Water towers, landfills, and electric cables punctuate the horizon. Joggers, horseback riders, and urban naturalists become our momentary companions.

## Northeastern Pine Barrens

In the Pine Bush, we are surrounded by flora and fauna well adapted to an unusual arid, fire-swept, acidic, nutrient-poor, permeable, and friable land. Early farmers found that vegetables and field crops produced poorly in this and similar areas of the northeastern United States. These areas are called barrens in both popular and scientific literature, meaning they are sterile, infertile, and unproductive. Early agricultural development on pine barrens was prevented by frequent fire and infertile soils that were easily disturbed by wind erosion and would not retain sufficient water for rewarding crop growth. In the mid 1800s, the Pine Bush was said to be "as forlorn, miserable and unsatisfactory a combination of sand, swamp and aridity, as the Union can produce . . . it is a mistake in nature, an enormous fraud on the worms and bugs which usually get a living somewhere on ordinary bad land . . ." (Munsell 1870, quoted in Rittner 1976c). With poor agricultural conditions and poor timber production, pine barrens fared well as undisturbed natural communities until the suburban developers of the late 20th century targeted these disused sites for development. Today pine barrens are imperiled, having been destroyed in the past century by land clearance, development, and fire suppression. These unusual ecosystems are anything but barren. They support a wealth of native species, including many rare, endangered, and threatened plants and animals.

The term *pine barrens* applies to several types of fire-prone, pine-dominated woodlands, savannas and barrens of the northeastern United States. These natural communities usually have an open canopy of the region's most fire-tolerant pine, pitch pine, and an understory of heaths (huckleberries, blueberries, laurels, etc.) or shrubby oaks (scrub oak, dwarf chestnut oak) or both heaths and shrubby oaks. Sweet-fern is a common associate. These communities are scattered throughout the eastern deciduous forest. Most occur on xeric (dry), nutrient-poor sites with excessively drained, sandy soil. A few occur on gravel deposits or exposed ridgetops of acidic bedrock. Ridgetop barrens usually do not have the diversity of plants and insects found in lowland barrens (Wheeler and Wilson 1996). Before European settlement of North America, pine barrens covered nearly 1.9 million acres (750,000 ha) in the Northeast. By the 1980s only half the original area still existed, and today less than a third persists (Kurczewski 1998).

Most pine barrens are located along the Atlantic Coastal Plain. The largest and best-known barrens are in southern New Jersey, situated on porous and acidic marine and glacial sands. They have a more southern flora and a mosaic of vegetation types differing from those of northeastern pine barrens. Northeastern barrens are primarily postglacial relicts. The large barrens of Cape Cod and Long Island are infertile, sandy relicts left behind after the retreat of the last glacier, some 12,000–18,000 years ago. Remnant pine barrens occur in pitch pine areas of southern

Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, and Pennsylvania. Fire-induced, oak-dominated savannas and some pine barrens dominated by jack pine, red pine, and white pine occur on dry, infertile soils in the midwestern United States and southern Ontario. Like northern pine barrens, oak savannas are disappearing rapidly due to habitat destruction and development (Nuzzo 1986).

Pine barrens are unique ecosystems that support species not found in nearby deciduous forest communities. Community composition and structure are affected by complex gradients of soil moisture and soil texture modified by a history of disturbance, especially fire and human land uses (Milne 1985; Motzkin et al. 1996; Whittaker 1979). Unusual and rare plants and animals occur in many barrens. These barrens-dependent species are imperiled by the adverse influences of agriculture, development, fire suppression, and expansion of the mesophytic northern hardwood forests that surround pine barrens.

Pine barrens are fire-dependent communities. Without fire at least every 15–20 years, birch, aspen, tree oaks, and other trees would invade, and the typical pine barrens community would disappear. Natural succession would probably lead to northern mixed forest or some other deciduous forest type. Pine barrens are prone to fire because the soils do not retain water well and because soil acidity retards microbial decomposition of organic matter, which leads to accumulation of a thick layer of flammable duff. Some barrens burn as often as every 6–15 years. Pine barrens trees, shrubs, herbs, and grasses are adapted to dry, infertile, fire-prone conditions. They are able to recover quickly following fire. Many species of insects and other animals mate, feed, and nest in the sandy openings and savannas in which these plant communities thrive.

In recent years many of the previously undeveloped barrens, once considered wastelands, have become increasingly attractive to residential, commercial, and industrial development. Fire suppression policies intended to protect economic interests and improve safety in these areas are threatening the continued existence of pine barrens plants and animals. Pitch pine–scrub oak communities are now conservation priorities because they are uncommon, they support rare plant and animal species, and development pressures seriously endanger them. Of course restoring fire to these communities is a management priority.

## New York Pine Barrens

In New York State, pine barrens occur on dry, acidic, infertile, sandy or gravelly soils, in sterile old fields, on thin soils of rocky ridge tops and summits, and on very shallow soils over noncalcareous bedrock. Pine barrens of central and western New York State are at the northwestern extent of the range of pitch pine. They are found on exposed sandstone, shale, lacustrine sand, and kame moraine. Pitch pines in this area tend to be associated with species typical of moderately moist conditions. Western New York sites are poorer floristically than those in New Jersey or on Long Island (Seischab and Bernard 1991). Pitch pine communities in northeastern New York are scattered around the edges of the Adirondack Mountains, where they occur on hard rock pavement of granitic gneiss or sandstone in the Thousand Islands region of the St. Lawrence Valley (Jefferson County) or on deep sands and gravels of glacial origin in Oneida, Saratoga, Clinton, Essex, Warren, Schenectady, and Albany Counties (Bernard and Seischab 1995). Pitch pine and ericaceous shrubs became important at the Rome Sand Plains (Oneida County) about 400–500 years ago, perhaps due to fires ignited by Indians. Continued disturbance by logging, land clearing, and fire have helped to maintain the barrens and convert mesophytic deciduous-coniferous forest to pine barrens (Kurczewski 1999).

Pine barrens in the upper Hudson Valley at Schaghticoke, Albany, and Cairo occur on lacustrine delta, sand dune, and outwash sand and gravel sites, respectively. The pitch pine barrens of the Albany Pine Bush are globally unique in that they are located inland and are the result of glacial sand deposition in a large freshwater lake rather than the ocean. Those in the lower Hudson Valley, primarily the Shawangunk Mountains, occur mostly on conglomerate rock sites. These communities are characterized by an open tree canopy and a distinct shrub layer of ericaceous plants, especially black huckleberry (*Gaylussacia baccata*). In the Shawangunks, dwarf ridge top pitch pine communities grade into taller pitch pine and oak forest on the slopes of the mountains (Seischab and Bernard 1996). The Long Island presettlement pine barrens communities grew on sandy soils of a glacial outwash plain south of the Ronkonkoma Moraine. Logging,

land clearance, and repeated human-caused fires promoted the expansion of pitch pine–scrub oak barrens vegetation through much of central Suffolk County during the 17th, 18th, and 19th centuries. Fire suppression in the 20th century has allowed reversion to oak-hardwood forest in northcentral Suffolk County and to oak-pine and pine-oak forests in south-central Suffolk County (Kurczewski and Boyle 2000).

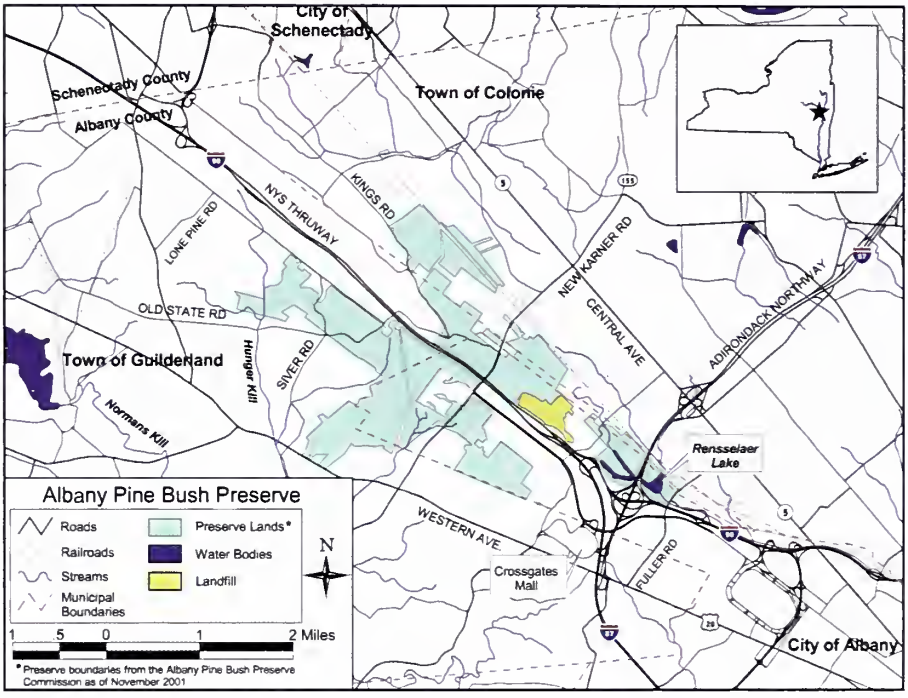
Pine barrens have been a part of the New York landscape for many centuries, but many of these habitats are now restricted to small areas that once were part of much larger communities. Oak-hickory or mesic northern hardwood forests surround many, and with fire suppression some barrens are succeeding to northern hardwood forest or mesophytic deciduous-coniferous forest. Most areas show evidence of timber cutting, agriculture, and building development. Larger tracts, such as those at Rome, Glens Falls, and the Albany Pine Bush, have been fragmented by development.

Efforts are underway to preserve the best remaining examples of pine barrens as nature preserves and open space for recreational activities, including nature study, hiking, cross-country skiing, and, in some areas, rock climbing. Agencies authorized by the New York State Legislature in 1988 and 1993 oversee preservation of the Albany Pine Bush (Albany County) and Long Island's Central Pine Barrens (Suffolk County). Pine barrens communities here and in the Shawangunk Mountains (Orange, Sullivan, and Ulster Counties), the Rome Sand Plains (Oneida County), the Clintonville Pine Barrens (Clinton County), and other areas upstate and on Long Island are preserved through combined efforts of various private and public entities.

## The Albany Pine Bush

The Albany Pine Bush is located on a gently rolling sand plain between the cities of Albany and Schenectady in the Capital District of Upstate New York. This unique environment of sand dunes and wetlands is located at approximately 42° 42' N, 73° 52' W, to the southwest of the confluence of the Mohawk and Hudson Rivers, south of the Adirondack Mountains and north of the Catskills. The Albany Pine Bush Preserve is within a 19-square-mile (50-sq-km) area of sand dunes bounded on the north by New York Route 5 (Central Avenue), on the south by U.S. Route 20 (Western Avenue), on the east by Fuller Road, and on the west by Route 146, Lone Pine Road, and Cordell Road. The Preserve is entirely within Albany County and includes portions of

the City of Albany, the Village of Colonie, and the Towns of Guilderland and Colonie. Within this area, more than 2,750 acres (1,114 ha) are now the focus of most biological studies and conservation efforts.




Pine Bush sand accumulated in Glacial Lake Albany after the Wisconsin glacier began to retreat about 20,000 years ago. As the glacier receded, Lake Albany extended north to Glens Falls from a Hudson Valley ice dam or other blockage near Newburgh. About 14,000 years ago, sand was deposited at a delta that formed at the site now occupied by the City of Schenectady, where the Mohawk River emptied into Lake Albany. The lake drained about 12,000 years ago, leaving these delta sand deposits and the lakebed sand and clay exposed to the forces of wind and rain. Today the remains of the ancient Pine Bush delta cover approximately 40 square miles (25,600 acres, 100 sq km) between Albany and Schenectady. Elevation ranges from about 260 to 360 feet (79 to 110 m) above sea level.

Although the Pine Bush as a whole has been referred to as the Albany Sand Plains, the term *sand plains* could be more narrowly construed to mean the relatively small areas among the Pine Bush sand dunes characterized by a flat to gently rolling surface dotted with blowouts and sand swells or low domes. Swamps or shallow ponds characterize blowouts that were long ago eroded into the sand. Sand plains are scattered throughout the Pine Bush, but they are most prominent in the northern and eastern portions.

Wind shaped the sand into dunes that wandered across the exposed delta until colonizing vegetation later stabilized them. Sand particles were blown by northwesterly winds into parabolic, longitudinal, and complex dunes 100–2,000 feet (30–610 m) long. Today the dunes appear as open, rolling slopes dotted with pitch pine and carpeted with the numerous understory plants. Dineen (1975) mapped the extent of former sand dune topography in the Albany Pine Bush. Dunes ranging from hundreds to thousands of feet long are clustered between Routes 5 and 20, and dunes 100 feet (30 m) high are common in the Curry Road area. They are typically oriented

with their longest axis running from northwest to southeast, and they are often parabolic, frequently resembling Us, Js, or Ys when viewed from above. Longitudinal and complex, nondescript dune shapes are also present (Donahue 1976).

A system of small streams drains the area. These streams are generally located within steep-sided, V-shaped ravines carved into the sand, and they have sandy bottoms. They have eroded through the sand cover and cut into the underlying clay beds deposited in the deeper water of Lake Albany. The streams are fed by groundwater perched in the sand above the impermeable clay. Because stream flow is controlled more by groundwater discharge than surface water runoff, the ravines do not routinely flood. Ravine walls are for the most part vegetated and stable. The vegetation of the cool, moist ravines is markedly different from that on the fossil dunes. The Lisha Kill and Shakers Creek flow north into the Mohawk River. In closer proximity to the area of focus, the Hunger Kill and Kaikout Kill flow south into the larger Normans Kill. The Normans Kill and Patroon Creek (fed by Rensselaer Lake) flow into the Hudson. Ground water drains westward into the Hunger Kill, southward into the Kaikout Kill, and eastward into Patroon Creek.

Generally, Pine Bush sands are at least 10 feet (3 m) thick, with an average surface relief of about 20 feet (6.1 m). The thickest sand deposits parallel state Route 5. In most areas, the soil is excessively well drained, and the surface tends to be very dry during summer. Wet, hydric soils occur for the most part in and adjacent to the northwest portion of the Preserve.

The climate in the Pine Bush is warmer and drier than that of the surrounding higher elevations. Winter climate is moderated by the surrounding mountain-river valley topography. Summer temperatures are among the highest in the state, and the fine, velvety, yellow-brown surface sands become extremely dry between rains. Precipitation averages 37 inches (94 cm) per year.

Good conditions for wildfires exist, especially during the frequent periods of high winds, because the sandy, acidic, nutrient-poor soil of the Pine Bush tends to be droughty, and a fuel supply of plant litter accumulates rapidly because of retarded microbial decomposition. Before the arrival of humans in the Pine Bush, fires occurred by chance, probably ignited by lightning strike. There is evidence that Native Americans later burned the area to improve hunting grounds. After the advent of European settlement, many fires were probably ignited intentionally or unintentionally.

Naturalists have long recognized the Albany Pine Bush as not a wasteland, but a rare and unique natural area. Disturbance determines to a large extent the composition of fire-prone Pine Bush communities. The community of plants and animals living in the Pine Bush is dramatically different from neighboring deciduous forests, where competition is a more important factor than disturbance by fire. The delicate balance of life in the Pine Bush has been maintained for thousands of years by periodic fires that serve to rejuvenate the natural community, drive out exotic plant species, and increase the food and habitat supply for native insects and other animals. The vegetation of the Pine Bush is distinguished by the widespread occurrence of dry pine and heath communities in a humid, forest climate. Pine barrens trees, shrubs, herbs, and grasses are adapted to dry, infertile, fire-prone conditions. They are able to recover quickly following fire. Extensive areas of pitch pine–scrub oak barrens occur in few other places on earth. However, the Pine Bush also supports at least 13 other community types, including forests, wetlands, and altered lands. The pitch pine–oak forest, pitch pine–scrub oak barrens, and pine barrens vernal pond are communities unique to pine barrens. The sensitive Pine Bush species and communities depend on periodic fires for their continued existence.

The ecological communities of this warm, arid island of sand dunes are home for an impressive and globally rare assemblage of plants and animals. The Pine Bush hosts a rich mixture of Atlantic Coastal Plain, midwestern, and northeastern species. The area is a northern outpost for many species with typically more southern distributions, including some species that occur nowhere else in the state except Long Island. Some typically western and northern species also occur in the Pine Bush. The area is known for the large number of plant and animal species whose ranges do not extend beyond the Pine Bush. Some are southern coastal plain species reaching their northern limit in the Pine Bush, while others are northern species reaching their southern limit here. Populations of some warm-adapted species are relicts left over from past periods of more hospitable climates.

The fire-adapted pine barrens plant community is dominated by pitch pine trees, with scrub oaks and dwarf chestnut oaks forming dense thickets in the shrub layer. A dense lower layer of sweet-fern, blueberries, black huckleberries, New Jersey tea, and bracken fern forms in treeless areas. Prairie grasses, including big bluestem, little bluestem, and Indian grass, are usually found along trails, at recently disturbed sites, and in some of the low areas between dunes where the water table may be very close to the soil surface. Characteristic forbs include bush-clover, goat's rue, and wild lupine. In areas that are largely free from fire, vegetation characteristic of the surrounding region develops. Invading aspens, birch, black locusts, sumacs, and other species usurp space once devoted to unique Pine Bush species.

The unusual and diverse assemblage of insects and other animals includes species that depend on the unique, fire-adapted plant community for food or find the unusually warm and arid conditions favorable to their lifestyle. For example, the buck moth, which in its larval stages feeds on oak, is close to its northernmost territory in the Albany Pine Bush. Many gall-forming insects build their homes in the scrub and dwarf chestnut oaks. Caterpillars of the threatened frosted elfin and the endangered Karner blue butterfly consume wild blue lupine. Fowler's toad, which is common on the Atlantic Coastal Plain from Long Island to North Carolina, tolerates the dry conditions of the Pine Bush well. Birdwatchers visit to see and hear birds rarely found elsewhere in Upstate New York. The prairie warbler is near its northernmost range in the Pine Bush, where it nests in low trees and shrubs on burned-over areas. The whip-poor-will prefers laying its eggs on the ground in dry woodland. It hunts saturniid moths and other prey by moonlight in adjacent open areas.

Many plant and animal species are in jeopardy in the Albany Pine Bush. These are species whose status is regarded as extinct or extirpated, rare, endangered, threatened, or worthy of special concern. Six rare plant species, 14 rare insect species, and 4 rare reptile and amphibian species reside in the Preserve. The best known is the Karner blue butterfly. Its type specimen, which is the scientific voucher specimen for this subspecies, was reared from a specimen collected in the Pine Bush in the 19th century. In 1977 the Karner blue butterfly became the first insect listed as endangered in New York State, and in 1992 it appeared on the federal list of endangered animals. Several other Pine Bush insects in well-studied groups are known to be rare in New York. We have little idea what rarities might exist in the lesser-known groups. Several Pine Bush grasses and sedges have been identified as threatened or endangered in New York State (Schneider et al. 1991; Mattox 1994). Many of these are associated with vernal ponds and other wetlands that are threatened by development and alterations to their hydrology. Among the vertebrates, the mammals and fish are generally secure. One bird, the northern harrier, is considered threatened in New York State, and Cooper's hawk, common nighthawk, vesper sparrow, and eastern bluebird deserve special concern. The endangered tiger salamander has been long absent from the Pine Bush, and the Jefferson, blue-spotted, and spotted salamanders are of special concern in New York State. The spotted turtle, wood turtle, worm snake, and eastern hognose snake are also of special concern.

Despite its old reputation as bleak, desolate, worthless wasteland, the Pine Bush has a long history of active exploitation for natural resources. Long ago, Native Americans used the area as a hunting ground. Indians and European settlers used the area heavily as a gateway from the Hudson Valley to the western frontier along the Mohawk Valley. European settlers found the Pine Bush generally unproductive for farming, but they logged it heavily for fire wood and lumber. Turpentine and tar were extracted from pine pitch. Vast amounts of surface sand were removed for use in foundry molding operations. Until recently sand pits, trash, and rusted vehicles littered the landscape. The area had been defiled by "fast-buck entrepreneurs eager to get something for nothing and by local residents eager to get rid of something for nothing" (Dirig and Cryan 1975).

However, scientists and naturalists who approach the Pine Bush with a noneconomic perspective find in this anomalous arid ecosystem, nestled among the vast surrounding deciduous forest climaxes, a treasure of rare and unusual glimpses of nature. Albany physician and lepidopterist James S. Bailey was impressed by the biological richness of the area.

> It is among the pine barrens and seemingly unfertile and inhospitable soil where is found so much to interest and instruct the student, for here he can commune undisturbed with

> nature, and at each step find his pathway strewn with objects of interest. Center [former name for Karner, New York] has a world-wide reputation botanically and entomologically. The collecting ground is embraced in a tract of one thousand acres, which civilization has never disturbed, but has allowed to remain in its primitive condition. (Bailey 1877)

More than 100 species of fungi, 70 species of insects, and an unknown number of vascular plants have been named new to science from Pine Bush specimens. From a scientific point of view, the Albany Pine Bush is the world's reference point for these species. It is the type locality, where the ultimate reference specimens, known as type specimens, originated. If the original type specimens are lost or destroyed, the Albany Pine Bush is the logical place to look for new specimens to help settle questions of species identity.

In the 1950s suburban developers noticed the Pine Bush, which is centrally located between two large cities. Residential, commercial, and industrial growth spread into the area from both sides. The natural wildfires that for thousands of years orchestrated the development of a unique association of plants and animals were no longer allowed to sweep through the area. Today numerous roadways, including several multilane highways, dissect the Pine Bush. Vehicle traffic in the area is generally heavy. Commercial development is concentrated along the major highways, except for the New York State Thruway. Industrial areas are found primarily on the north side of the Preserve. The Albany Landfill is located west of the Rensselaer Lake area of the Preserve. Large areas of residential development are found to the southeast, southwest, and west of the Preserve. Numerous pending development and road improvement proposals threaten to further shrink the Pine Bush.

Human activity in the Pine Bush has disturbed the landscape and increased habitat diversity. Hundreds of nonnative vascular plant species have been introduced since the time of European settlement. Introduced mammals, birds, insects, and other animals are common and often associated with human habitation. These species compete with the native species and add to the peril of species already in jeopardy. Fire suppression, habitat loss and fragmentation, introduced species, lowered water tables, and pollution threaten the continued existence of the Pine Bush ecosystem.

After more than three centuries of human disturbance, including urban and industrial growth, only about 2,000–2,500 acres (809–1,012 ha) of natural Pine Bush communities remain intact amidst the tangle of interstate highways, residential developments, shopping malls, and industrial parks that dominate the western edge of the City of Albany and adjacent portions of the Towns of Colonie and Guilderland. This remnant is only about 10 percent of the original 25,000-acre (10,118-ha) ecosystem that developed on postglacial sand dunes. This remaining Pine Bush supports the association of distinctive natural communities that typify a pine barrens ecosystem, along with various disturbed communities and those that have been invaded by successional hardwood species due to fire suppression.

Most Pine Bush community types are secure throughout their respective ranges (Reschke 1990). However, the pitch pine–scrub oak barrens community is imperiled globally throughout its range, the rich sloping fen is vulnerable globally throughout its range, and the pine barrens vernal pond is uncommon and possibly vulnerable globally throughout its range (Reschke 1990; Mattox 1994).

Until recently few people considered the Albany Pine Bush worthy of preservation. Like other northeastern pine barrens, the area was held in low esteem. Scrubby vegetation, searing summer heat, frequent uncontrolled fires, and a reputation as a dumping ground contributed to the indifference of society. Ignorance of the ecological significance of the Pine Bush is attested to by the fact that there have been many parks and game preserves in the surrounding northern deciduous forests for a long time, but none in the Pine Bush. By the mid 1970s, however, this situation had changed as a result of grass-roots environmental movements, and conservation was underway. Today the Albany Pine Bush Preserve is composed of tracts owned by New York State, the City of Albany, The Nature Conservancy, and the Towns of Guilderland and Colonie that total about 2,750 acres (1,113 ha).

# Geological History

The arid sands that comprise Albany Pine Bush soils and play a central role in the ecology of the area are merely a youthful veneer over evidence of millions of years of geological history. Buried deep beneath the sands is shale and sandstone bedrock, originally deposited as layers of mud and sand in an Ordovician sea some 400–500 million years ago. These rocks were later gently folded or squeezed together during an episode of mountain building in the eastern United States, and the sea withdrew. The preglacial Mohawk, Alplaus, and Colonie Rivers eroded the soft shale that was exposed between sandstone hills and ridges, forming valleys and giving the bedrock surface over 300 feet (91 m) of relief. Of course modern drainage patterns in the Pine Bush do not follow these bedrock valleys. Today, the generally impermeable bedrock is buried 50 feet (15 m) or more underground. The buried valleys of the preglacial rivers are filled with, and concealed by, overlying unconsolidated glacial till, stratified drift, and lake clay and silt. These deposits are mostly products eroded from the bedrock by the overriding Wisconsin ice sheet and subsequently more or less sorted and redistributed by water and wind. Their groundwater potential has been the subject of considerable attention (Dineen 1975, 1982).

The warm and humid Cretaceous Period, the final stage of the Mesozoic Era, ended some 65 million years ago. Dinosaurs and a majority of all other species became extinct, the earth cooled down, and permanent polar ice caps formed. The ensuing cold Cenozoic Era was a time of intense tectonic activity and changing climate patterns. The continents moved to their present positions, and major mountain ranges grew to their present heights. About 1.8 million years ago, the final Cenozoic stage, known as the Quaternary Period, began with the Pleistocene Epoch. The Pleistocene was a time of several ice ages followed by warm interglacial ages similar to the one we enjoy today, which is known as the Holocene Epoch. The last ice age, known as the Wisconsin episode, began about 80,000 years ago. At its peak, about 20,000 years ago, the Laurentide ice sheet covered some 5 million square miles (13 million sq km) from the Arctic Ocean to eastern Canada, New England, and northern half of the Midwest. It stretched from the Atlantic Ocean to the foot of the Rocky Mountains, where it met the Cordilleran ice sheet. Numerous ice lobes advanced and retreated along the margin of the Laurentide ice sheet, but a general wasting and retreat of glacial ice began about 18,000 years ago. Snow and ice that had accumulated over tens of thousands of years, reaching up to 2 miles (3.2 km) thick in parts of North America and Eurasia, wasted away in only a few thousand years. As the ice thinned and retreated to the north, ice-dammed lakes, some of immense size, formed along the southern margin of the ice sheet. When they drained, they caused catastrophic flooding. By 7,000 years ago, only small remnants of the Laurentide ice sheet remained. A fresh landscape of youthful glacial landforms was left behind (Dawson 1992; Erickson 1990).

Glaciers have advanced across the Pine Bush several times in the past million years, scouring, shaping, and smoothing the bedrock surface and depositing sediments over it. During the last major episode of glaciation, the ice sheet reached across New York State as far south as Long Island and Staten Island. Glacial ice in the Capital District may have exceeded half a mile (0.8 km) in thickness. With much of North America under a tremendous burden of ice, the ancient sea level was lower than today's by as much as 350 feet (107 m), and the Hudson River carved its way through the present-day continental shelf for another 120 miles (193 km) out to sea. Mastodons and mammoths roamed the banks of the now-submerged Hudson. The advancing ice carried a great burden of rock debris scoured from Canada and the Adirondack Mountains. As it moved southward, it eroded bedrock and soil and deposited glacial till. This unsorted mixture of boulders, gravel, sand, and clay formed thin blankets, terraces, and drumlins. Today buried glacial till, 5–150 feet (1.5–46 m) thick, directly overlies the bedrock under almost all of the Pine Bush. It is thickest in the preglacial valleys. Glacial till underlies much of the area east of Guilderland. Till is exposed in steep slopes along the Normans Kill. The buried Hartmans drumlin field, extending from the drumlins north of Voorheesville to state Route 5 near Route 155, is a thick area of glacial till. Glacial till generally restricts groundwater movement and makes a poor groundwater reservoir (Dineen 1976).

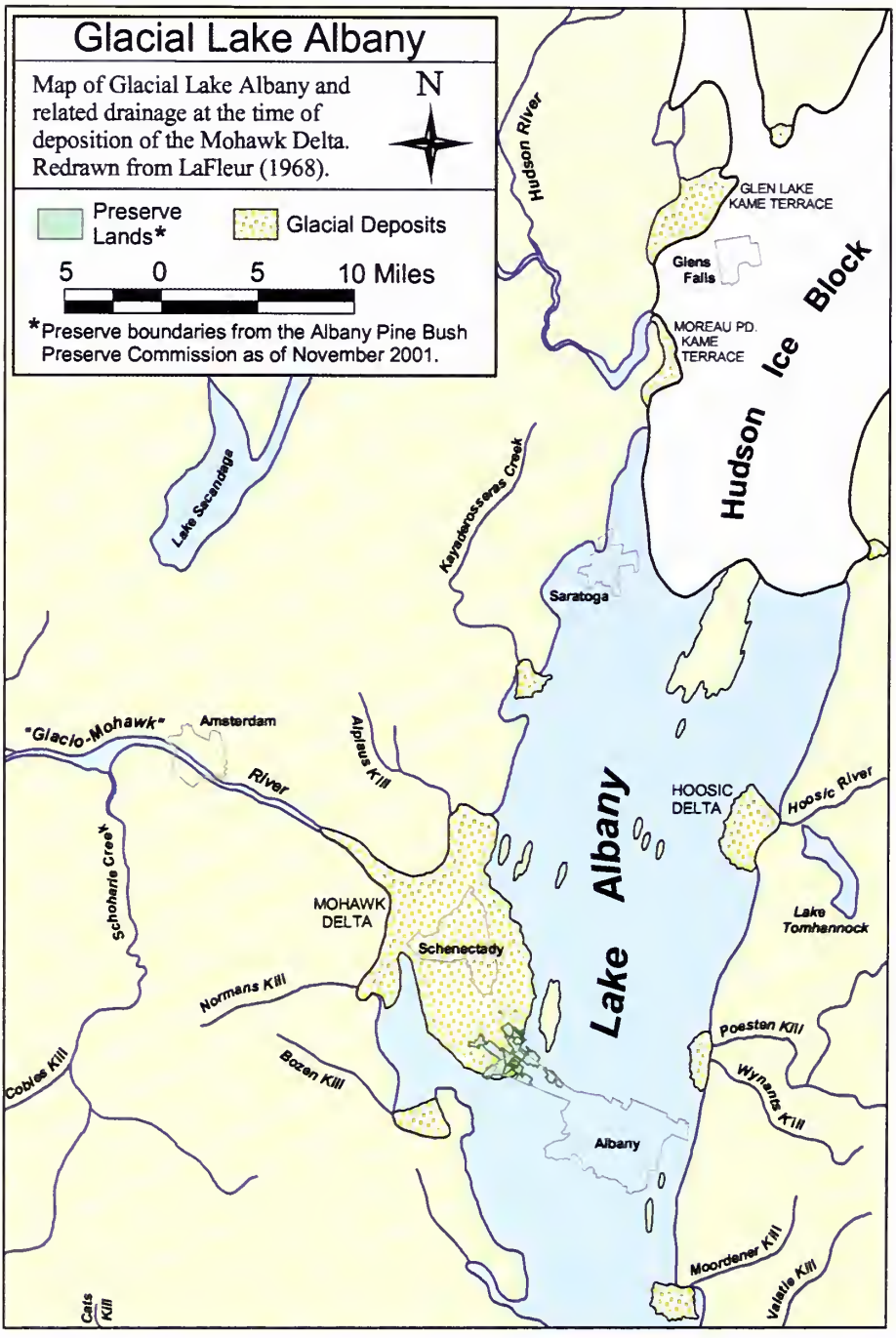
About 18,000 years ago, the Laurentide ice sheet began to thin and recede irregularly northward. Water from the melting ice sorted sediments and redeposited graded sand and gravel as stratified drift over large areas of the Pine Bush in thin sheets and terraces and as long, winding

ridges called eskers. Poorly sorted material was deposited close to the glacier, while well-sorted material was deposited farther away. Today stratified drift composed of layered sand and gravel overlying till is exposed along the Normans Kill. The Guilderland gravel terrace, on the southwest edge of the Watervliet Reservoir on U.S. Route 20, and the Loudonville esker, which run north-south along U.S. Route 9, are other examples of exposed stratified drift. Fullers gravel terrace, northwest of the Albany city line, and the Elsmere gravel blanket, east of Westmere, are also examples of stratified drift. Stratified drift ranges from 10–150 feet (3–46 m) thick and forms the best subsurface aquifer in the Pine Bush. High yield wells can last many years. The buried Fullers gravel terrace, more than 50 feet (15 m) thick and buried 50–150 feet (15–46 m) below ground level, is perhaps the best reservoir of deep subsurface water in the Pine Bush.

Recession of the Late Wisconsin ice northward through the Hudson-Champlain Lowland of eastern New York was accompanied by development and subsequent drainage of a sequence of glacial lakes. From 18,000 years ago to about 15,000 years ago, the glacier receded from Long Island to the mid Hudson Valley. An ice dam or other blockage of uncertain structure developed in the Hudson Valley in the vicinity of Newburgh. Water from the melting glacier, contained to the south by the Newburgh blockage and to the north by the wall of retreating glacial ice, filled the Hudson Valley and vicinity. This lake expanded northward as the Hudson Valley lobe of the Wisconsin ice sheet retreated. It reached the Albany area about 14,000 years ago, and the Pine Bush region was submerged under water to a level 330 feet (101 m) above present sea level. The shores of Lake Albany extended to the present day uplands to the east and west of the Capital District and to the retreating glacier to the north. The elongate lake eventually stretched 160 miles (257 km) from Newburgh, New York, in the south to Glens Falls, New York, in the north. It lasted from 15,000 to 12,600 years ago. The lake received gravel, sand, and clay from the glacier. Gravel and sand were deposited near the glacier's margin, but silt and clay washing directly out of the melting ice block spread as cloud-like blankets over the lake bottom, forming fine, rhythmically banded sediments. Meltwater currents flowing into the lake became weaker as the glacier retreated northward, and the sediments contributed by this time tended to be finer-grained clay and silt.

As the back-wasting ice cleared side valleys of the Hudson Lowland, rivers emptied directly into Lake Albany. The Glaciomohawk River flowed through the Mohawk Valley and reached Lake Albany at Schenectady, where Mohawk Delta deposits of cobbles and gravel can now be found. Fine sands, silt, and clay were carried farther east through the Mohawk Delta into Lake Albany, and these are now found at the upper surface of the Pine Bush. Other river and stream currents flowing from the west, east, and south also created deltas at the edge of Lake Albany. Lake Albany acted like a giant settling tank in which relatively uniform deposits of clay and sand could form. Clays were deposited first. The clays, derived by ordinary processes of surface weathering from easily attacked particles of Hudson River shales, formed the bond found in Albany molding sands. Clay deposits are impermeable to water, and ponding sometimes occurs at the surface above them. Pine Bush lake clay and silt deposits average 50 feet (15 m) thick, and today they are generally exposed only in stream valleys and gullies. As the glacier wasted away, the unburdened land uplifted, and Lake Albany began to drain 12,000–13,000 years ago, leaving many smaller lakes behind. In the final stages of Lake Albany, sands were deposited in great quantity. As lake levels dropped, deltas migrated across the lake, and sand was deposited over the older clays (LaFleur 1968, 1976). Occasional large erratic boulders found among the finer sediments are believed to have dropped from floating icebergs (Nevin 1925).

When the lake level reached 270 feet (82 m) above sea level, wind and streams began to erode the exposed shore and sand plain. The cool, dry climate of the time and the impoverished soil of lake sands inhibited development of vegetation and succession of ecological communities in the Pine Bush area. Wind eroded lake sands into finer particles, scoured depressions into the landscape, forming wetlands in some areas, and blew the sand into the dune formations found here today covering the old lakebed. The area of exposed sand plain became larger as the lake fell. Streams cut into the exposed lake floor, forming ravines. Dune building continued until about 5,000 years ago, when colonizing vegetation encroached upon the blowing sands. Although the Pine Bush is the principal dune area on the bed of Lake Albany, dunes also formed in Saratoga County at Clifton Park and Stillwater (Cook 1930).


Glacial Lake Albany
Map of Glacial Lake Albany and related drainage at the time of deposition of the Mohawk Delta. Redrawn from LaFleur (1968).
N
Preserve Lands*
Glacial Deposits
5 0 5 10 Miles
*Preserve boundaries from the Albany Pine Bush Preserve Commission as of November 2001.
Hudson River
GLEN LAKE KAME TERRACE
Glens Falls
MOREAU PD. KAME TERRACE
Hudson Ice Block
Lake Saratoga
Kayaderosseras Creek
Saratoga
"Glacio-Mohawk" River
Amsterdam
Alplaus Kill
Lake Albany
HOOSIC DELTA
Hoosic River
Schoharie Creek
MOHAWK DELTA
Schenectady
Lake Tomhannock
Normans Kill
Poesten Kill
Wynants Kill
Cobles Kill
Bozen Kill
Albany
Moordener Kill
Valatie Kill
Cats Kill

## Postglacial Biotic Development

As the ice retreated northward, the climate ameliorated, soils matured, and plants migrated northward. The composition of the flora and fauna of Upstate New York changed. Vegetation began to alter the character of the soil, and in the Pine Bush it eventually stabilized the wandering dunes. Presumably subarctic plant communities consisting of mosses, lichens, sedges, and low shrubs developed first. As the glacier retreated farther north, this tundra-like vegetation was followed by boreal spruce-fir forests and then, about 9,500–9,000 years ago, by pine forests. In New York State, pine forests dominated for 1,500–2,000 years. While surrounding lands developed mixed hardwood vegetation, including oak-hemlock mesic forest, the Pine Bush perhaps remained xeric and relatively depauperate in its plant composition.

It is likely that the forest of the Pine Bush was different from the surrounding pine forest. The early pine forests of the Albany Pine Bush area also included oak and birch, trees that thrive in areas that burn frequently. Evidence suggests that the area supported dry land herbaceous plants as well, and the land was not completely covered with vegetation. Rain percolates quickly through the sterile quartzose Pine Bush sand, so the pines that dominated here probably were drought-resistant species capable of surviving in infertile soil. The dry, acidic soils discouraged decomposition, so pine needles and other plant debris accumulated and fueled wildfires. Wildfires encouraged the establishment of fire-resistant species, and because of the periodic destruction of organic matter, only thin and rudimentary topsoil developed over much of the Pine Bush.

About 7,000 years ago, the pine forests of Upstate New York were giving way to mixed hardwood forests similar to the ones we see today stretched across most of the New York landscape. This type of forest cannot survive in dry, nutrient-poor, fire-prone conditions. Evidence indicates that 5,000 years ago the vegetation of the Pine Bush was similar to that which is found here today. Indeed, it appears that the fire-resistant pitch pine has been present for at least the last few thousand years in the Pine Bush. Palynologist Donald M. Lewis, of the New York State Museum, surmised that a decrease in the relative abundance of oak pollen deposition in the upper, more recent strata of Poplar Street Bog could correspond with diminishing importance of tree oaks and increased importance of shrub oaks of the kind found in the barrens today. If this is true, then barrens as we know them have existed for at least 3,000 years in the Albany Pine Bush (Lewis 1976). When Henry Hudson arrived at the beginning of the 17th century, oak-chestnut-hickory forests extended through the Hudson Valley from Manhattan to Glens Falls. At higher elevations, beech, maple, yellow birch, and hemlock grew. In the Pine Bush, fire-prone, mesophytic species concentrated along the ravines and wetter areas, but a pitch pine–scrub oak community grew among the dunes. The barrens vegetation may have developed naturally over thousands of years due to the arid nature of the area and the influence of wild fires. On the other hand, it is possible that fires were not so frequent in the past, and a dense forest of white pine and oak overgrew the Pine Bush. Indians and European settlers later felled the forest and intentionally or unintentionally encouraged fire. Fire and extensive clear-cutting may have destroyed the original humus, acidified the soil, and permitted the establishment of a fire-resistant barrens community. Under this scenario, man, rather than nature, provided the disturbance that created the pine barrens of the Albany Pine Bush (Huey 1975; Reilly 1975).

Holocene climate did not warm continuously for 10,000 years. During this interglacial period, there have been some relatively small-scale climate shifts. Between 6,000 and 4,000 years ago, during the Mid Holocene hypsithermal interval, a worldwide thermal maximum, often called the climatic optimum, occurred, and it was followed by a period of climatic retrogression. Average temperatures in many regions of the world were slightly warmed, and flood waters from melting ice caps raised sea levels by 300 feet (91 m). During the hypsithermal (or altithermal) interval major vegetation change occurred in the midwestern and southeastern United States. Increased warmth and aridity in the Great Plains resulted from increased strength of prevailing westerly winds. Prairie, oak savannah, and oak-hickory forest shifted eastward as the mixed hardwood forest of the Northeast was reduced in area. By 5,000 years ago, southern pines reached up the coast from Florida to Long Island (Delcourt and Delcourt 1981). Attempts have been made to explain noteworthy occurrences of Pine Bush warm-climate plants and animals as relict distributions persisting in the relatively warm and dry Pine Bush since the hypsithermal period (Stewart and Rossi 1981; Stewart and Ricci 1988). Some species are thought to have

arrived in the Pine Bush via the Prairie Peninsula corridor from the Great Plains, whereas others moved up the warm lowland corridor of the Hudson Valley from the Atlantic Coastal Plain.

As the hypsithermal period ended, the climate became cooler and moister, and the eastern deciduous forests spread from cool, moist refugia to cover most of the land. The Pine Bush remained a warm oasis that continues to host the offspring of colonizers from a warmer era. Under this interpretation, big bluestem, little bluestem, Indian grass, bush clover, wild lupine, Fowler's toad, the Karner blue butterfly, and the inland barrens buck moth are understood to be species of likely western origin that reached the Pine Bush via the Mohawk Valley. Pitch pine, scrub oak, goat's rue, butterfly-weed, bayberry, sand cherry, box turtle, spadefoot toad, worm snake, and the hognose snake are considered Atlantic Coastal Plain species that probably reached the Pine Bush via the Hudson Valley. However, it should be noted that many of the so-called relict species found in the Pine Bush, such as the bluestem grasses and Indian grass, are actually geographically widespread eastern North American taxa of open habitats.

An alternative biogeographic hypothesis was refined by Frank Kurczewski (1998), an entomologist with the New York State College of Environmental Science and Forestry in Syracuse. He hypothesized that 20,000–12,000 years ago, during full- and late-glaciation, many characteristic pine barrens plants and animals, such as wild lupine and the Karner blue butterfly, thrived in the southern Atlantic Coastal Plain. As climate ameliorated, beginning 14,000–12,000 years ago, plants and animals dispersed slowly northward along the low, uninterrupted sandy coastal plain. From the lowlands of New Jersey, they dispersed northward through the Hudson Valley, and then westward to the Great Lakes Region through the Mohawk Valley and along the Ontario-Erie Lake Plain. They also dispersed eastward to Long Island and the lowlands of New England. These inland dispersal corridors were similar to the coastal plain, providing virtually uninterrupted low-elevation, wind-worked sands of glacial origin. Inland areas of New England and Upstate New York were covered with pine woodland before about 8,000–7,000 years ago. Pine barrens may have reached their greatest extent around that time, or a little later when mean summer temperatures were a little higher and precipitation, water tables, and lake levels were lower than they are today. The eastern Great Lakes were smaller, and more sand was exposed 8,000–6,000 years ago. Pine barrens that are now small and isolated were probably larger then, and some may have been joined together as vast mosaics of barrens communities, providing an uninterrupted stretch of favorable habitat that pine barrens plants and animals could move across from east to west.

Late in the Holocene, the climate cooled and became wetter. Water tables and lake levels rose. Greater soil moisture, fewer lightning strikes, and infrequent natural fires encouraged the growth of deciduous and deciduous-coniferous forests, and these forests became the dominant vegetation type of the Northeast after 6,000 years before present. Barrens and savanna areas contracted or disappeared as mesophytic forests expanded. Many sandy tracts were soon covered by beech, maple, hemlock, basswood, elm, and birch. Except for tracts cleared and burned regularly by natives, few fire-dependent communities remained in Upstate New York when European settlers arrived. Unlike coastal and western Great Lakes portions of the pine barrens belt, New York and inland New England portions were characterized by infrequent and light wildfires (Bormann and Likens 1979; Patterson and Backman 1988; Seischab and Orwig 1991), so pine barrens communities were not as likely to endure here.

Modern plant and animal distribution patterns reflect geological, climatic, and human history. Today, wild lupine grows in dry, sandy soils along the Gulf of Mexico coast from eastern Texas and Louisiana to Florida, up the Atlantic coast to southern Maine, and westward across New England and New York to the western end of the southern Great Lakes region in Minnesota. Before many barrens were rendered uninhabitable by agriculture, development, and other disturbances at the hand of man, the Karner blue, frosted elfin, and Persius dusky wing skipper, butterflies whose caterpillars feed on lupine, presumably occurred widely across New England, New York, southern Ontario, and the southern Great Lakes Region in association with wild lupine. However, the antennal-waving wasp, *Tachysphex pechumani* Krombein, has a historically disjunct or discontinuous distribution that cannot be explained solely by human interference and habitat destruction. It inhabits grassy areas of pine barrens savannas and open woodlands only in sections of Michigan's Lower Peninsula, northwestern Ohio, southwestern Ontario, and the New

Jersey Pine Barrens. It is probable that this wasp occurred much more widely early in the Holocene, and the present distribution reflects the nearly total replacement of the fire-dependent pine woodland, savanna, and barrens with closed-canopy, mesophytic, deciduous forest. Populations of the wasp became isolated and severely reduced in size. Isolated populations are threatened with local extirpation because of demographic, genetic, or catastrophic processes that work on small populations (Kurczewski 1998).

Species more typical of cooler, northern climates have persisted after glacial retreat in the cool, moist Pine Bush ravines. These include starflower, goldthreads, false lily-of-the-valley (Canada mayflower), yellow birch, shining club moss, wood frog, northern redback salamander, spotted salamander, Jefferson salamander, spotted turtle, wood turtle, and southern red-backed vole.

## Climate and Seasonality

Today the climate of the Albany Pine Bush is warmer and drier than that of the surrounding landscape, and therefore the area is more susceptible to fire. The climate is primarily continental in nature. Winters are cold, but not severe. Surrounding river valleys and mountains moderate winter cold air masses from Canada. There are 169 frost-free days per year. Summers are warm. A moderate maritime effect coming from the southeastern part of the state influences climate during summer months. Some of the highest temperatures in the state are recorded from the Pine Bush region. Air temperatures range from 102° F (39° C) in summer to -8° F (-22° C) in winter (Thaler 1992). The mean annual temperature is 48° F (8.8° C). Most precipitation falls from late spring through summer. The least precipitation occurs in the first quarter of the year. The Catskill and Adirondack Mountains produce a rain shadow effect that reduces the amount of total precipitation in the Pine Bush. Average annual total precipitation is 33 inches (84 cm), including about 67 inches (170 cm) of snow (Smith 1976).

Animal communities change markedly with season in the Pine Bush, as they do in most of the North Temperate Zone. Many plant species are deciduous, and the food supply they produce fluctuates through the year. The flush of young oak foliage in spring is a huge food resource for herbivorous insects. Large populations of caterpillars, in turn, feed many birds and mammals. When leaves fall, the bird community changes, and many mammals retreat to their dens for winter.

## Soil and Water

The delta and lake sands that were scoured and reworked by wind action as Lake Albany drained more than 10,000 years ago now blanket the Albany Pine Bush. This mantle of sand ranges from 5 to 150 feet (1.5 to 46 m) thick. The smooth, velvety, yellow-brown to light gray surface sands consist of fine to medium-sized, subangular grains. Most surface sands lack abundant silt and clay because these particles were blown away while the dunes were being built, although the presence of large quantities of coarse silt in some dunes suggests that the winds driving the blown materials were at times of low velocity. Stronger currents would have carried the silt particles farther downwind (Donahue 1976). Microscopic evidence of glacial crushing, frost splitting, and stream abrasion can be seen on the particles of quartz that dominate the sand. Some grains have spherical shapes or frosted surfaces indicative of prolonged wind activity.

Pine Bush soils are young. Living organisms, climate, and other soil-developing factors have had little time to work since Lake Albany drained. In upland pine barrens habitats, organic matter from decaying plants and animals has not enriched soils to a significant degree because this material burns off periodically. The U.S. Department of Agriculture Soil Conservation Service has mapped 33 soil types in the Pine Bush area. These are primarily sands and sandy loams, with Colonie Loamy Fine Sand being the dominant upland soil type in the Preserve area. Colonie soils are characterized as being very deep, well-drained to somewhat excessively drained, rapidly permeable, strongly to medium acid, coarse-textured soils that formed in outwash or lacustrine materials and associated aeolian, gravel-free deposits dominated by fine and very fine sand. The surface layer is about 7 inches (18 cm) of dark brown, loamy, fine sand. The subsoil is about 61 inches (155 cm) of yellowish brown, loamy, fine sand with very thin dark brown bands of loamy fine sand. The substratum is brown, loamy, fine sand to a depth of 80 inches (203 cm)

or more. The seasonal high water table in Colonie soils is at a depth of more than 6 feet (1.8 m), but it can rise to 3.5 feet (1.1 m) for very brief periods in early spring.

Elnora soils, which occupy nearly level to undulating beach bars, old off-shore sand bars, and sandy deltas, are also prominent in the Pine Bush landscape. They are characterized as being very deep, moderately well drained, moderately to very rapidly permeable, and very strongly acid to neutral. The surface layer is about 8 inches (20 cm) of dark brown, loamy, fine sand, and the subsurface layer is about 3 inches (8 cm) of very dark gray, loamy, fine sand. The subsoil is yellowish brown, fine sand about 16 inches (41 cm) thick, and the substratum, which extends to a depth of 65 inches (165 cm) or more, is brown, loamy, very fine sand that overlies dark gray, loamy, fine sand. The seasonal high water table in Elnora soils is at a depth of 1.5–2.0 feet (0.5–0.6 m) from February to May.

Stafford soils, which formed in sandy deltas, off-shore bars, and beach deposits associated with glacial lake and melt waters, are very deep, somewhat poorly drained, and strongly acid to slightly acid, and the seasonal high water table is 0.5–1.5 feet (15–46 cm) below the surface from January to May.

Poorly drained, hydric soils occur primarily in and adjacent to the northwest portion of the Preserve. Granby loamy fine sand, which is very deep, poorly drained, and only slightly acid to alkaline, occurs in flat and slightly depressed areas of glacial lake plains or deltas. The seasonal high water table is at a depth of less than 1 foot (0.3 m) from November to June (Brown 1992; Landry and Rosenberg 1976).

Pitch pine–scrub oak barrens occur on acidic soils with very low specific conductance values. However, at around pH 4.1, these soils are less acidic than those on conglomerate rock sites in the Shawangunk Mountains. They contain about 90 percent sand, 7 percent silt, and 3 percent clay. Sandy barrens on lacustrine deposits in Schaghticoke and outwash sand deposits in Cairo have about four times as much silt and twice as much clay. Seischab and Bernard (1996) hypothesized that the heavier soil and lack of recent disturbance accounts for the larger trees, fewer shrubs, and the well-developed herb layer that characterize the Schaghticoke and Cairo sites. Apparently the higher percentages of silt and clay in the soils at Schaghticoke and Cairo allow more mesic trees and herbs to grow there.

There is ample biotic evidence that not all Pine Bush substrates are highly acidic. Several biologists have remarked on the presence of calciphilic (lime-loving) plants. Dirig (1994) observed that wild lupine is apparently a calciphile, needing some lime in the soil to thrive. In the Pine Bush, it occurs locally near other lime-loving plants, such as harebell (*Campanula rotundifolia*), starry false Solomon's seal (*Maianthemum stellatum*), and butterfly-weed (*Asclepias tuberosa*). He hypothesized that these plants are associated with lime deposited during glacial runoff from the nearby Helderberg Mountains. Mattox (1994) encountered a small area of rich sloping fen while surveying the wetland vascular flora. This community type typically occurs on slopes composed of calcareous glacial deposits. Calcareous water percolating through the terraced slope creates rare habitat for a sandy area. Some of the plants that occur here are calcicoles that thrive on the mineral-enriched water. The community harbors such Pine Bush rarities as fringed gentian (*Gentianopsis crinita*), bog twayblade (*Liparis loesellii*), northern bog clubmoss (*Lycopodiella inundata*), and purple fringed orchid (*Platanthera psycodes*).

The sand mantle of the Albany Pine Bush serves as a reservoir and water-processing system. Sand deposits are highly permeable and contain large quantities of water. They can support wells with high yields. Excess water accumulates in the sand during wet months and is released during dry months through springs along stream bottoms. About half of the precipitation that falls on the sand is processed by the ecosystem and used as a vehicle for the transport of energy and nutrients. Surface water percolates quickly into the sand, leaving the sand surface arid during dry summer months. Less permeable lake silts and clays underneath the sand contain an upper, sand plain aquifer. Its water table lies 5–12 feet (1.5–3.7 m) below the ground surface. Percolating ground waters are exposed in springs, marshes, wetlands, and wells where the sand topography intersects the water table. In ravines, these waters supply streams that drain the sandy carpet. The perennial streams drain away a large portion of the precipitation that annually falls on the sandy carpet. This water leaves the Pine Bush ecosystem as surface runoff via such streams as the Hunger Kill and Lisha Kill. Wetlands have developed in areas where the sand sur-

face is low. A constant exchange of water with the ground water system prevents wetlands from becoming stagnant, and chemical substances are filtered from the groundwater by wetland biota. Another permeable unit, consisting of sand and gravel deposited by meltwater flowing into Lake Albany as the glacier retreated from the Albany area, underlies the silt and clay layer. This lower aquifer contains large quantities of water under artesian pressure (Buttner 1976; Dineen 1979).

Characteristics of the sandy Albany Pine Bush surface soils have had a major impact on the flora and fauna that developed and continues to thrive here. Because there is little silt, clay, or organic material to help bind the soil, it is friable, providing an excellent substrate for burrowing insects, snakes, toads, and other animals. Roots also penetrate the loose soils easily.

Upland soils dry quickly after summer precipitation, and so the flora and soil fauna tend to consist of drought- and desiccation-resistant species. The drought-resistant plant community affects the structure of the herbivorous insect community and associated higher predators. Desiccation-prone amphibians and invertebrates, such as earthworms, are restricted to moist, lowland areas.

The quartz comprising the bulk of the sandy soil is naturally infertile. The rapid infiltration of precipitation through the highly permeable surface sand leaches out available nutrients, thus contributing to the maintenance of a dry, nutrient-undernourished surface and a saturated, nutrient-enriched subsurface. The vegetation that dominates upland areas of the Pine Bush tends to be composed of drought-resistant species capable of surviving on sterile soils. Pitch pine and white pine survive in dry conditions, while red oak, red maple, and other hardwoods tend to occupy sites with higher water tables. A high water table or moist conditions combined with fire suppression, either by human practices or natural fire breaks, accelerates the establishment of hardwoods that can cast more shade than pines, thus eliminating shrubs that thrive in full sun on frequently burned and dry sites (Milne 1985).

The dry, acidic, sandy soil does not promote decomposition of litter, and the litter that is decomposed by fungi is not incorporated into the soil by earthworms and other organisms, which do not tolerate the dry upper layers of sandy soil. Dry pine needles, oak leaves, and other plant litter accumulate on the droughty soils, providing fuel for frequent fires. As a consequence of these periodic fires, much of the nitrogen in organic matter is volatilized and lost, especially when fires are severe. Although fire probably has little direct effect on the physical and chemical properties of the soil, nitrogen-fixing bacteria should be favored under these circumstances. Legumes, such as wild lupine, with their nitrogen-fixing nodules, occupy burned sites readily, where they have a temporary advantage. Some other nutrients could be lost through volatilization, runoff, and convective loss of ash, but many are added to the surface of the soil as ash. A nutrient pulse that lasts for several months after a fire can contribute to a dramatic increase in growth rates.

Fire removes shade and insulation from the soil surface and reduces its reflectivity, leading to higher daily temperatures and consequent increased plant productivity and soil organism activity. High temperatures from fire may also sterilize the soil surface by destroying allelopathic compounds, such as those produced by bracken. The removal of biomass and consequent increased temperatures and wind speed result in decreased soil moisture through higher evaporation and loss of moisture in soil litter. Little topsoil, or only a thin, rudimentary topsoil, develops over much of the Pine Bush, and the dry, impoverished nature of the soil is maintained. The presence of pine barrens in a temperate deciduous forest climate results from the success of low nutrient- and fire-adapted species in invading and maintaining themselves competitively over the last several millennia on sandy soils having low water- and nutrient-holding capacity.

Certain plants would not thrive in the sand and poor soils of the Pine Bush if it were not for symbiotic fungus-root associations called mycorrhizae. The relationship is characterized by the flow of organic resources from plant to fungus and inorganic resources from fungus to plant. The fungi obtain high-energy carbohydrates from the host plants, while the plants are rewarded with increased underground absorbing surface, helping them to obtain nitrogen, phosphorus, water, and other scarce nutrients. Early successional sand dunes tend to have nonmycorrhizal plants. Lack of mycorrhizae is especially evident in the plant families Chenopodiaceae and Brassicaceae, which have many weedy, invasive, annual species found on disturbed lands in semiarid habitats. Mycorrhizal activity increases with increased organic matter, soil development, and plant community succession. The composition of the plant community shifts from nonmycorrhizal

species, to facultative mycorrhizal species, to obligate mycorrhizal species. Obligate mycorrhizal pines and oaks appear on late seral dunes. Postfire invasion of certain plant species may require prior establishment of appropriate symbiotic fungi (Allen 1991).

## Fire Ecology

The postglacial biotic development of Upstate New York described above is an example of primary succession on barren terrain. As climate warmed with glacial retreat, tundra vegetation developed first, followed by boreal forest, then pine forest, and finally a climax community that replaces itself and does not change unless there is substantial climatic change or perturbation. The stages of succession involve more than just climatic change. Each stage alters the character of the soil, light conditions, water relations, and many other physical, chemical, and biological components of the habitat. These changes allow certain species to persist and compete better than others, so the composition of the biota changes gradually until, theoretically, a steady state is reached in which the climax community of plants and animals that makes the most efficient use of available resources persists. The community established by nature is the one what works best given the climate and other characteristics of the area. In the area surrounding the Albany Pine Bush, the pre-European settlement vegetation was presumably the climax community for this area. When Henry Hudson arrived at the beginning of the 17th century, oak-chestnut-hickory forests dominated much of the Hudson Valley. At higher elevations, beech, maple, yellow birch, and hemlock grew. According to theory, these are the climax forest communities that should dominate the Albany Pine Bush.

Ecologists have long marveled that such a different kind of community, the pitch pine–scrub oak community, predominates in pockets within the temperate deciduous forest belt. They turn to ecological disturbances to explain this phenomenon. Disturbances are events that remove organisms and open up space that can be colonized. After human urban and agricultural activities, fire is the most ubiquitous terrestrial disturbance. Other disturbances include herbivory (insects, deer, etc.), droughts, floods, and hurricanes. In areas that are not prone to disturbances, changes in species composition of the biotic community are largely determined by the ability of species to invade a site and their position in the competitive hierarchy. Generally speaking, species that require the high light intensity, but tolerate the low fertility, of barren landscapes are gradually replaced by species that tolerate low light, but require more nutrients found in forested areas with well-developed soils. In the absence of fire and human disturbance, succession in the upland areas of the Pine Bush would probably result in a hardwood forest dominated by oak. In moist sites, other hardwoods, such as red maple, would probably be part of the community.

In fire-prone areas, the abilities of invading species to disperse into a site and compete for resources such as light, water, and nutrients are less important factors in determining community composition. The abilities of existing plant species to tolerate fire, retain occupancy of the site, and recruit new individuals become the overriding factors. Postfire community changes are the result of interactions between fire characteristics, such as intensity and frequency; processes and conditions that occur after fire, such as microclimatic conditions and herbivory; and fire-related survival and dispersal attributes of the organisms. With only occasional fires, a community of fire-resistant oaks and white pines would probably develop on the uplands of the Albany Pine Bush. In the relatively long intervals between fires, propagule invasion and plant competition may again become factors in changing community composition. With more frequent fires, ability to survive fire becomes of primary interest, and species interactions in the interval between fires are of peripheral interest. Short fire intervals result in elimination of all species except those most resilient to the effects of fire. Communities that develop following disturbance are called disclimax communities (Whelan 1995).

Wildfire is much more likely to occur in some areas than in others. Its likelihood is influenced by many factors, including soil characteristics, weather, fire history, plant community composition and structure, and history of insect outbreaks. For a plant community to burn, good fuel and oxygen supplies and a source of ignition are required. The fuel, of course, is biomass, both living and dead, and fire characteristics will be determined ultimately by the amount of energy stored in the biomass fuel. Flammability is improved when fuel is plentiful, dry, and warm,

and each of these characteristics is to some extent dependant on soil and weather. Droughty soils, warm and dry air, rapid accumulation of well-aerated, dry litter, and occasional high winds create good conditions for wildfire. When appropriate fuel conditions are present, communities in lightning-prone areas should burn more frequently than others. Lightning is the chief natural source of ignition, but, undoubtedly, humans ignite most contemporary fires.

The propensity to burn also depends on the morphological and chemical attributes of plant species in a community and the spatial arrangement of biomass. Production and retention of dry, dead material is important because combustion of dead fuels drives the moisture out of living tissues, making them combustible as well. Tough, fibrous, long-lived leaves of drought-resistant species tend to promote fire, and plants with high levels of oils, fats, waxes, and terpenes can be highly susceptible to fires.

The barrens communities of the Albany Pine Bush are fire-prone. The dry, acidic soil promotes growth of drought-resistant species and rapid litter accumulation. Compared with surrounding forests, the barrens are warm and dry, and because of their open canopy, winds can further dry the landscape and fan flames. The pitch pine–scrub oak community is characterized by numerous highly flammable plant species that have high concentrations of volatile secondary compounds and strategies for fire survival and postfire regeneration. Pines, grasses, and heaths are fire-prone because their finely divided leaves lose moisture quickly. Pine pitch is highly flammable, and the scrub oaks produce a plentiful supply of dry, dead leaves that tends to accumulate in well-aerated mounds among the abundant, scraggly twigs. Less flammable, mesic plant communities are concentrated in the ravines. The ravines act as natural fire breaks because steep downward slopes prevent preheating of fuel ahead of the fire as it approaches the ravine. Fires are more likely to proceed upward in steep topography because the flames can warm the fuel and drive out moisture as the fire moves uphill.

*Courtesy Ron Gill*

Fire alters the physical conditions that prevail in a habitat. It removes the shading, windbreaking, and insulating effects of living and dead biomass. The dark ash deposited on the soil surface reduces its light reflectivity and alters its chemistry. Postfire soil is more exposed to light, reaches higher maximum temperatures, and loses more water through evaporation. Fire increases the availability of most nutrients through ash deposition, heating of organic matter, and

increased rates of biological mineralization, although nitrogen and some other nutrients might be lost through runoff, convective loss of ash, or volatilization in severe fires. The postfire nutrient pulse can last for several months.

The character of a fire and the altered habitat it creates have profound implications for the recovery of the flora and fauna. Although fire's immediate effect is the removal of aboveground biomass, both living and dead, many plant species are subsequently stimulated by fires, and they respond with enhanced productivity, flowering, seed germination, and seedling recruitment. The postfire nutrient pulse and exposure of mineral soil are especially important. Increased productivity can result from increased nutrient availability in ash, removal of suppressive dead leaves, increased soil temperature, and removal of competing vegetation. Increased flowering can result from the increased nutrient availability, an increased number of shoots sprouting, and removal of competing vegetation. Increased levels of seed germination can result from increased seed release from heat-treated fruits or cones, increased water absorption by heat-treated dormant seeds, or stimulation by chemicals released in fire. Improved seedling establishment can occur because of increased nutrient availability, decreased postfire herbivore activity, removal of competing vegetation, or degradation of allelopathic chemicals.

The postfire environment is hostile to many vertebrates and invertebrates because of the scarcity of food and lack of cover from predators. However, recovering plant communities often show improved nutritional levels for several years. Improved nutrition can improve growth, reproduction, and survival rates in animal communities as well.

Fire shapes the structure of pine barrens communities and is essential for their long-term maintenance. It eliminates competition from species that cannot tolerate dry, nutrient-poor conditions, while stimulating species that do tolerate these prevailing conditions. Fire in the Pine Bush destroys small plants of fire-intolerant species, thus eliminating these species from the community. It maintains nutrient-poor soil conditions in the long run by repeatedly destroying accumulated organic matter on the soil surface. Fire thereby limits competition from species that require higher nutrient levels, the species that would replace typical Pine Bush plants in the normal course of succession. Fire provides a suitable seedbed for specialized pine barrens plants by maintaining nutrient-poor soil conditions, exposing sandy mineral soil to sunlight, and increasing soil temperature. It thereby stimulates germination and sprouting of fire-tolerant species, which in the aftermath of the fire can grow without competition from fire-intolerant species.

Fire drives population and community change in fire-prone communities. However, fires are not all alike, and each community or habitat has an individual set of fire-regime characteristics that includes average fire intensity, normal season, average extent or patchiness, fire type (ground surface, crown), and average frequency or time elapsed since the last fire. For example, the fire regime of North American coniferous forests could be described as low-intensity surface fires during dry summer periods every 1–10 years and high-intensity crown fires every 100 or more years.

Different fires and fire regimes affect the physical environment in different ways, and because plant species tend to be specialized to a particular frequency, season, or intensity of fire, different fire regimes can favor one species over another, thereby contributing to changes in community composition. For example, low-severity fire increases herb diversity and stimulates growth, but severe fire limits diversity and retards growth. Communities with patchy fuels have heterogeneous burning patterns, which create heterogeneous communities. When fires occur at short intervals, some species may not be able to survive because they do not grow and reproduce quickly enough.

In the warm, droughty Albany Pine Bush, fire occurs frequently, presumably preventing the ecosystem from reaching an equilibrium or climax condition with production equaling respiration, in which there is no net change in total biomass over time. Different sites within the Pine Bush have been subjected to different combinations of fire intervals and intensities, so fire regime varies among sites (Milne 1985). Different fire frequencies interrupt succession in different ways, thus accounting for most of the current variations in forest composition, and obscuring any effects of soil differences. Many types of pine barrens are maintained by fire return intervals of fewer than 20 years. It is believed that pitch pine–scrub oak barrens require fire every 6–15 years, or competitive succession will eventually transform the community into hardwood forest

(Reschke 1990). Periodic wildfire at, perhaps, 40-year intervals have produced pine and tree oak forests in the Pine Bush. The fire return interval for the relatively fire resistant northern hardwood forest seems to be on the order of 100 or more years (Bormann and Likens 1979). In the Albany Pine Bush, wildfire in late spring and summer is unlikely because relative humidity tends to be high, and nonflammable green foliage abounds. The fire season first arrives in the spring with the passage of dry cold fronts and returns in the fall when stagnating high pressure leads to Indian summer. Fires in northeastern pine barrens are most common in April and May, before leaves of deciduous trees appear (Motzkin et al. 1996). The mildly undulating, well-drained Pine Bush surface has few natural fire firebreaks, other than some steep-walled ravines, so before development created numerous artificial fire breaks, such as railroad lines and roads, fires were able to sweep through extensive areas relatively unimpeded.

## Fire History

Before European settlers arrived, the northeastern United States experienced infrequent and light wildfires. However, there is good evidence that fire-dependent pitch pine–scrub oak communities dominated the Pine Bush landscape at the time the earliest European settlers arrived in the area, and before. When British administrator Thomas Pownall traversed Kings Highway in the Pine Bush while on his way from Albany to Schenectady in the 1750s, he clearly found this barrens community in abundance (Pownall 1949).

> The soil of the Land through which this Road goes is Sand for the first Seven Miles, the Timber nothing but Pitch Pine, the Underwood Fern in great Quantities, some Shumack and Dwark Oak, Four Miles more the same; a wet Bottom crosses the Land here of about a Mile; the Wood Birch, Aspin, Chestnut, Oak; the remaining Five Miles much the same as before. I observed in the Woods many flowers, as the Heart's-ease, the Blue Lupin, the Convolvolies; and in the swampy bottoms, the Orange Lilly, and the Iris.

Yale College president Timothy Dwight, who visited Schenectady in 1798, observed, "On three sides it is nearly enclosed by the brow of a lofty pine plain, always an unsightly disagreeable object." Of his 16-mile ride to Albany, he wrote, "The road passes over a pitch pine plain, nearly a perfect flat, chiefly covered with a forest, the soil miserably lean, the houses few and poor, and the scenery remarkably dull and discouraging. The road also is encumbered with sand and, unless immediately after a rain, covered with an atmosphere of dust" (Dwight 1969, Vol. 2, Letters 16 and 17). The barrens nature of the Pine Bush vegetation at this time, and later, was confirmed by many other early travelers (see Huey 1975; Rittner 1976c). Frequent fire was obviously an important part of the Pine Bush 250 years ago or barrens vegetation could not have existed.

A hundred years earlier, in the early 1640s, Dutch colonist Adriaen van der Donck, who had been responsible for collecting the patroon's rents in Rensselaerwyck, observed that the Indians of the region regularly burned the woods in autumn and spring to improve hunting and vegetation (Van der Donck 1968).

> The Indians have a yearly custom (which some of our Christians have also adopted) of burning the woods, plains and meadows in the fall of the year, when the leaves have fallen, and when the grass and vegetable substances are dry. Those places which are then passed over are fired in the spring in April. This practice is named by us and the Indians, "bush-burning" which is done for several reasons: First, to render hunting easier, as the bush and vegetable growth renders the walking difficult for the hunter, and the crackling of the dry substances betrays him and frightens away the game. Secondly, to thin out and clear the wood of all dead substances and grass, which grow better the ensuing spring. Thirdly, to circumscribe and enclose the game within the lines of fire, when it is more easily taken, and also because the game is more easily tracked over the burned parts of the woods.
>
> I have seen many instances of wood-burning in the Colony of Renssalaerwyck where there is much pine wood. Those fires appear grand at night from the passing vessels in

the river, when the woods are burning on both sides of the same. Then we can see a great distance by the light of the blazing trees, the flames being driven by the wind, and fed by the tops of the trees. But the dead and dying trees remain burning in their standing positions, which appear sublime and beautiful when seen at a distance.

The Pine Bush at that time and later probably approached much closer to the Hudson River. In 1798 Timothy Dwight observed that "The site of Albany is an interval on the western side of the Hudson, and the brow of an elevated pine plain rising rapidly at a small distance from the river" (Dwight 1969, Vol. 2, Letter 17).

There are numerous reports by early European explorers of Native-set fires in North America, and much anthropological evidence suggests that fire has been actively used for thousands of years for hunting and clearing undergrowth. Timothy Dwight in 1796 concluded that pitch pine and oak forests were especially selected for this purpose because in ordinary years only these areas were sufficiently dry. He speculated that the pine barrens of New England had been burned for more than a thousand years (Dwight 1969, Vol. 1, Letter 8). Forests were also cleared to satisfy the Indians' prodigious demand for firewood and to open fields for agriculture. Ecologists, anthropologists, and historians agree that North American Indians had a significant and widespread historical influence on their environment through extensive forest burning (Budiansky 1998; Day 1953; Pyne 1982).

Study of fossil pollen samples found in cores taken from the Poplar Street bog in the Town of Colonie (just north of Route 5 and east of Route 155), now destroyed by development, has revealed much concerning the fire and vegetation history of the Pine Bush (Lewis 1976). The bog was probably a shallow pond that received considerable amounts of wind-borne sand until about 3,000 or 4,000 years ago, when it developed into a bog with pitcher plants, sundew, and a few spruces. At least some of the surrounding land was savanna-like in appearance, not fully vegetated, throughout much of the period from about 8,000 to about 2,000 years ago. The presence of small amounts of dry-land herb and grass pollen with charcoal and wind-borne sand throughout the 6,000-year core column, from oldest to youngest sample, supports this conclusion. Various species of soft and hard pines were dominant throughout much, if not all, of this period. The soft pine was probably white pine, and the hard pine could have been red pine, jack pine, or pitch pine, or some combination of species. Throughout the 6,000-year period represented by the bog's pollen record, oak and birch, trees that pioneer on repeatedly burned sites, were part of the Pine Bush pine forest. Evidence of periodic fires in the Pine Bush, in the form of charcoal and oscillations in pine pollen levels, was found in pollen samples dating back to the time when hardwood forests were developing in the regions surrounding the Pine Bush. In relatively recent time, but more than 2,000 years ago, pine pollen reached a high level, and oak pollen declined. This may be due to establishment of a closed pine forest and suppression of the shrub oak understory during a fire-free period.

The extensive assemblage of specialized Pine Bush Lepidoptera (butterflies and moths) is further evidence that strongly suggests that the fire-dependent pitch pine–scrub oak community has existed here for millennia, although it is possible that in earlier times, when the Pine Bush was more expansive, this community shifted about in time in response to fires and other disturbances (Schweitzer and Rawinski 1988).

Fire became a regular feature of the Albany Pine Bush landscape thousands of years ago.

Fire regime is likely to have varied widely over time, and the variation is likely to have been ecologically significant. In the absence of fires caused by humans, lightning was probably the most general and widespread cause of wildfires. However, there is little if any documented evidence pointing to lightning ignitions as an important ecological factor in the Pine Bush or surrounding area. In the northern hardwood forest region, lightning ignitions are rare, and their frequency is dwarfed by that of human ignitions (Bormann and Likens 1979; Seymour et al. 2002). Furthermore, many periods of suitable fire conditions, with high fuel loads and warm, dry, breezy weather, probably passed without a fire for the lack of a dry lightning storm. In the Pine Bush region, as in the most of the Northeast, convective thunderstorms are almost always accompanied by heavy rainfall, which extinguishes any lightning ignitions. Most forest fires caused by lightning striking trees originate in dry fuel at the base of the tree. The finely divided fuels of the Pine Bush, such as pine needles, are highly susceptible to wetting by rainfall, and this decreases the probability of ignition (Taylor 1969). It would be unwise to completely dismiss lightning ignitions as an ecological force in the Pine Bush. However, it seems unlikely that lightning could have ignited fires frequently enough, and that those fires would have been of sufficient intensity and extent, to explain the existence of pitch pine–scrub oak barrens.

Humans have been visiting the Pine Bush for the thousands of years in which fires have raged here. Paleoindians probably hunted caribou here around 10,000 years ago (Ritchie 1976). At least one artifact from that period has a blunted end that suggests it was used for striking fire. Around 4,000 years ago, Late Archaic Indians of the River phase hunted, fished, and gathered wild plant foods in a region whose boundaries closely conform to the former bed of Lake Albany. These seminomadic people moved within their range from place to place and established camps to use the available food resources. They collected acorns, which they roasted over beds of hot stones to drive off the toxic tannic acid. Fire-broken rocks, flint chips, projectile points, and a few other artifacts from these and later peoples have been found in the Pine Bush area. Indians of the Late Woodland stage, dating from about A.D. 900 to 1300, were village dwellers who practiced horticulture and built bark- or mat-covered houses. They made ceramic pots and pipes and many stone, bone, and antler items.

Fire was a common tool of aboriginal peoples the world over. Anthropologist Omer C. Stewart (1956) convincingly argued that wherever man traveled, he made campfires and left them to ignite any and all vegetation in the vicinity. Native peoples were rarely careful to extinguish their campfires. They intentionally tried to leave them smoldering slowly. After all, it was difficult work to make fire without a glowing ember. An untended fire in flammable, fuel-laden pine forest on droughty, sandy soil in windy weather is quite likely to ignite the dead biomass and living vegetation as well. It is also likely that early Pine Bush visitors deliberately ignited bush fires. Dense brush was of little use to hunters or gatherers, and heavy growth was dangerous because it concealed human and animal enemies. Brush removal improved visibility and facilitated travel. Fire was used to drive game for many thousands of years in North America and in just about every other corner of the globe. Broadcast burning to remove old growth and improve forage and grazing conditions was practiced by hunting peoples from the Atlantic to the Pacific in the United States. The fact that the Iroquois and Algonquin Indians of the northeastern United States practiced vegetation burning at the time of European discovery to clear fields for agriculture and open forests for hunting was carefully and thoroughly documented by Gordon M. Day (1953).

Early European settlers and farmers found cleared or barren areas, stripped of forest and litter by Indian fires, and enriched by ash, to be favorable areas to begin their American farming experience. Furthermore, the fire practices of the early settlers were little different from those of the Indians they displaced. They adopted fire hunting and broadcast fire to clear land for pasturage of wild and domestic animals. They expanded the process of agricultural reclamation through slash-and-burn practices and other routines begun by the Native people of the Northeast. Because of massive killing of valuable game, bans on fire hunting were among the first fire codes adopted in the Northeast (Pyne 1982).

Fire regimes in the Northeast have undergone enormous changes in the past four centuries due to the growing impact of intentional and accidental human ignitions. After the advent of European settlement in and around the Albany Pine Bush, anthropogenic ignitions caused by

land-clearing activities, camp and picnic fires, careless smoking, vandalism, and sparks from passing trains became more prevalent. In the late 1800s, the leading causes of fire in the Northeast were, first, land-clearing activities, followed by firing for pasturage and hunting and fire from locomotives. With the great variety of ignition sources available, fewer suitable days and sites could escape fire. More than 90 percent of all fires on Long Island at the turn of the 20th century were attributable to human origin (Kurczewski and Boyle 2000).

Early locomotives were notorious fire starters. Albany historian John McEneny (1981) tells us that, on August 9, 1831, when the world's first steam passenger train made its inaugural trip between Albany and Schenectady, it burned foul Lackawanna coal and showered the flammable brush of the pine barrens with sparks. Within 11 years it was possible to travel all the way from Buffalo to Boston by railroad, and soon the giant of American railroads, the New York Central, ran through the Pine Bush. By the mid 1800s, more than 200 passenger trains passed through Albany daily. The impact of train-ignited fires in the Pine Bush has not been documented, but it is probable that railroads were a major influence in the expansion and maintenance of pine barrens vegetation here, as they were elsewhere. On Long Island, pine barrens fires became so extensive and destructive after the railroad was launched in 1844 that trains were blamed for "burning out the middle of the Island" (Kurczewski and Boyle 2000). On the Rome Sand Plain, sparks generated by the steel rails, firebrands erupting from the smokestacks of wood or coal-burning locomotives, and glowing embers dumped beside the tracks were frequent modes of ignition (Kurczewski 1999).

## Fire Suppression

By the latter part of the 19th century, agricultural reclamation of land by forest clearing waned. The nation, particularly the Northeast, became concerned about the prospects of a timber shortage and damage to watersheds by forest clearing. Organized fire protection originated in the Northeast. New York was among the first states to enact fire codes to regulate the agricultural uses of fire, and a rural fire warden system was established. Major northeastern fires in 1903 and 1908 had national repercussions in the campaign for forest conservation and organized fire control. The federal Weeks Act of 1911 allowed for cooperative agreements and a system of matching funds between the U.S. Forest Service and state foresters to provide fire protection on public lands. The states soon signed up for the program. Forest conservation became a new national concern, and fire suppression policies soon emerged. Systematic fire protection on the state and regional levels was well organized by the 1930s. Fire protection organizations were put into place, and they were supplied with new fire-fighting technology, including the gasoline-powered fire engine. By the middle of the century, nearly all wildfires of low and medium intensity were being extinguished (McCullough et al. 1998; Pyne 1982). Society had been trained to view fire as undesirable, and it worked to suppress fires in the Albany Pine Bush and elsewhere. Fire suppression has had profound effects on vegetation patterns. Woodlands have replaced grasslands, forests have replaced shrublands, and broad-leaved trees have invaded conifer forests. Fire is still widely seen as an agent destroying the "balance of nature" rather than a process that helps preserve much of the world's diversity (Bond and van Wilgen 1996). Even trained ecologists have been slow to appreciate the role that fire plays.

Human activities have altered various aspects of the Albany Pine Bush fire regime. Fire frequencies almost certainly increased at one time due to greater frequency of ignitions associated with centers of population. In the pitch pine–scrub oak community on the Montague Plain in central Massachusetts, extensive fires were fairly common early in the 20th century. In recent decades, the number of small, accidental fires has increased dramatically, but the number of extensive fires has decreased due to improved fire detection and suppression (Motzkin et al. 1996). It is likely that a similar pattern has operated in the Albany Pine Bush. Here an organized program of fire suppression became critical in the 1950s, with suburban development and the opening of the New York State Thruway. Nonetheless, at least 65 large fires burned in the Pine Bush between 1935 and 1987 (Zaremba et al. 1991). Fuel conditions changed with the introduction of nonnative plant species and fire suppression. Hydrological changes brought about by changing land use patterns also have probably altered fuel conditions. Fire extent has decreased because

roads, towns, and agricultural clearing all act as firebreaks. A survey of records concerning Pine Bush fires suggests that individual fires have burned areas up to 1,200 acres (486 ha), with 100 acres (40 ha) perhaps being typical (Zaremba et al. 1991; Gebauer 1996).

A program of prescribed burning was introduced to the Albany Pine Bush in the 1990s, in recognition of the area's fire-dependence. With the growing acceptance of fire's role in ecosystems, prescribed, controlled fires have become a tool for restoration of historic plant communities. They are often justified as fuel-reduction burns, intended to reduce the potential intensity of future wildfires. With development and man-made firebreaks, it is impossible to duplicate the natural, historic fire regime. Because of the fragmented nature of the remaining Pine Bush, prescribed fires must be of a limited extent. Fire season has been altered with the introduction of cool-season, hazard-reduction burning. Fire intensity has changed because prescribed burns are controlled, light burns.

Departure from the historic intensity, frequency, season, or extent of the regional fire regime can be expected to influence the composition of the biota. Because of human activity in the Pine Bush, the intensity, frequency, and extent of future fire regimes will be greatly reduced from those of the past, and the season of future prescribed burns will be determined in part by such human factors as safety concerns and convenience. With reduction or removal of fire as a constant, severe perturbation, competition has again become an important component of community change. In pitch pine–scrub oak barrens, faster and taller growing tree species, such as white oak, northern red oak, black oak, white pine, and black locust, displace shade-intolerant pitch pine and scrub oaks. During the past several decades since coal-burning locomotives stopped running through the Rome Sand Plain, pine barrens there have been reverting to mesophytic deciduous-coniferous forest. Some sections have succeeded from pitch pine–heath barrens to Appalachian oak–pine forest in fewer than 50 years (Kurczewski 1999). In the absence of disturbance, especially fire, the Albany Pine Bush barrens would probably succeed first to closed-canopy pitch pine forests, then to more diverse communities dominated by a mixture of pitch pine, white pine, red oak, white oak, red maple, scarlet oak, black cherry, and white ash (Milne 1985; Seischab and Bernard 1996). On fire-suppressed, dry, upland sites in the Albany Pine Bush, high densities of young white pine have been found under aging pitch pines (Milne 1985). Most pine barrens plant species persist for many years without fire while other non-fire-adapted species invade the community, but after several decades of fire suppression pine barrens sites lose their characteristic structure and species composition. Relatively shade tolerant broadleaved hardwoods eventually would shade out fire-tolerant species such as pitch pine and shrub oaks. Animal communities, primarily herbivores, would respond to such changes, and many characteristic Pine Bush insects would disappear. Pine barrens vernal ponds, which also depend on recurrent fires during dry periods to maintain open vegetation, would succeed to red maple hardwood swamp.

## Human Disturbance

When studying the development of pine barrens plant and animal communities, it is necessary to consider the impact that man has had on the ecosystem. As we have seen, bush burning by natives is likely to have had a major early impact on the flora that developed in many areas. After European colonists arrived in North America, fire, agriculture, and other human disturbances increased dramatically, and in many cases these disturbances have determined the type of vegetation that occupies a pine barrens site today. For example, pitch pine and heaths began to dominate the Rome Sand Plain in Oneida County, New York, some 400–500 years ago, following increased disturbance by Indian fires. The barrens were maintained through the 19th and 20th centuries by logging, land clearance, and fires associated with brush removal, a railroad, agricultural activity, and arson. Evidently fire destroyed the accumulated organic matter and led to decreased available soil moisture and nutrients. Fire-susceptible mesophytic northern hardwoods and hemlock did not fare well on the disturbed soils. Pine barrens plant species, including pitch pine, scrub oak, sweet fern, bastard toadflax, butterfly-weed, and wild lupine, invaded the site from the surrounding woodland. However, with the fire suppression policies of recent decades, the barrens are reverting to mesophytic deciduous-coniferous forest, which the fine-

textured clay- and silt-enriched loamy sands can support (Kurczewski 1999). The pine barrens of Long Island are thought to have expanded in response to 17th-, 18th-, and 19th- century logging, land clearance, and repeated fires ignited by humans. Before European settlement, pitch pine–oak–heath woodland, pitch pine–scrub oak barrens, and dwarf pine plains probably occurred only on the deep, coarse-textured, excessively drained, nutrient impoverished, acidic, fire-prone sandy soils of the outwash plain south of the Ronkonkoma Moraine. Pitch pine and scrub oak later established on disturbed loamy, sandy, and gravelly soils. The central Suffolk County pitch pine–oak–heath woodland and pitch pine–scrub oak barrens were enlarged and reshaped for 200–300 years, but with 20th-century fire suppression, these communities reverted to hardwood and deciduous-coniferous forests on the richer and finer-textured soils. Pine barrens persist on the droughty, fire-prone outwash sands (Kurczewski and Boyle 2000).

In pine barrens communities, variation in vegetation patterns is largely accounted for by variation in the history of disturbance by fire and land use. Although fire history has had an important influence on the composition of Albany Pine Bush vegetation, it is only one of the disturbances that have altered the usual course of ecological succession on sandy soils in a humid, temperate climate. Modern Pine Bush vegetation patterns probably have resulted from fire influencing vegetation composition and structure within a pattern of species associations largely controlled by historic land use. Land use history has a striking and overriding impact. An interesting example of this phenomenon is found in a study of the Montague Plain in the Connecticut Valley of central Massachusetts. The Montague Plain is similar to the Albany Pine Bush in that it is a sandy outwash delta deposited into a glacial lake that once occupied a large river valley. It is in an area where lightning-ignited fires are few, but fires ignited by Indians were probably quite common before European settlement. Harvesting of forest products was the primary land use until the early 1800s. However, much of the Montague Plain was then plowed for agriculture until the early 1900s. Today it supports a pitch pine–scrub oak community.

On the Montague Plain, many plant species, including sweet-fern, black and fire cherries, whorled loosestrife, and white and scarlet oaks, have successfully recolonized abandoned sites that were plowed a century ago. Today these species are well represented both on plots that were formerly plowed and those that were never plowed. However, pitch pine, gray birch, little bluestem, and hair-cap mosses (*Polytrichum* spp.) occur most frequently and abundantly on sites that were once plowed and then abandoned from agricultural use. Pitch pine requires exposed mineral soil and open-canopy conditions for successful establishment. Few recent fires have been severe enough to create these conditions, so nearly all pitch pine occurs on abandoned plowed fields. After its initial establishment, dominance of fire-resistant pitch pine is influenced by fire history. In the absence of fire, hardwoods and white pines would increase. A third group of species, the numerous weedy and early successional species, also is more abundant on disturbed plots. A fourth group consists of species that are slow to recolonize sites from which they were once removed by plowing. They may be absent over a hundred years after agricultural use of the site was abandoned. Most scrub oak, dwarf chestnut oak, black huckleberry, lowbush blueberry, and wintergreen grow on sites in which the soils were never disturbed by the plow (Motzkin et al. 1996). These sites were probably forested in the past, but repeated fires and cutting have stimulated vigorous sprouting of these barrens species and promoted stability of scrub oak stands by removing developing tree canopies that would shade them out. Low soil moisture in formerly plowed sites and competition from successfully colonizing species, such as pitch pine, may also account for the general absence of this group of species from former agricultural land.

The influence of land use history has not been thoroughly studied in the Albany Pine Bush, but modern vegetation patterns here have certainly developed from species-specific responses to human activities, including burning, cutting, agriculture, and sand mining. Many modern communities are probably similar in species composition to those that have occupied the Pine Bush for millennia, but the present-day structure and spatial arrangement are the outcome of cultural history. The section of this book dealing with human exploitation of the Pine Bush amply demonstrates the magnitude of influence that man has had on this fragile ecosystem.

Finton (1998) interpreted recent and historic aerial photographs to determine 20th-century changes in the distribution of Albany Pine Bush plant community types. Between 1928 and

1940, the most prominent trend in land cover change on a 1290-acre (522-ha) study area was the conversion of pitch pine–scrub oak forest to more typical barrens communities, suggesting that this time period was dominated by timber cutting activities, perhaps for lumber or in preparation for development. From 1940 to 1990, the dominant trend on a 4,798-acre (1,942-ha) study area was an increase in developed land. One hundred thirty-seven acres (55 ha) of agricultural land and 1,555 acres (629 ha) of wild land, most of it supporting pitch pine–scrub oak communities, were developed. Nearly 40 percent of the study area was permanently removed from natural vegetation during this 50-year period. At the same time, 705 acres (285 ha) of grassland-heath and pitch pine–scrub oak communities gave way to hardwoods, and closed-canopy communities widely replaced open-canopy communities.

Although agriculturally disturbed areas of the Montague Plain were later invaded by pitch pines, hardwoods invaded similar areas in the Albany Pine Bush. The Albany Pine Bush, unlike the Montague Plain, supports a healthy population of black locust. Neither area is within the original natural range of black locust, but this widely planted species made its way to the Pine Bush, where it has escaped from cultivation. It is a shade- and competition-intolerant species, a pioneer and prominent species in old fields and other disturbed sites with no competing woody canopy. It is especially common on sites of abandoned farms and residences in the Pine Bush, and it probably increased following human activities that destroyed living root systems of the shrub oaks originally on the site. Many shrub-oak-dominated areas of the Pine Bush have a complex history of recent, repetitive disturbance that does not destroy the roots (Milne 1985). Black locust grows rapidly and out-competes native species, such as pitch pine, that otherwise would probably establish on disturbed sites. In the absence of frequent wildfires that kill young trees, this non-native species has covered large areas of the Albany Pine Bush, in some areas forming pure stands and displacing pitch pine, scrub oak, and other native species by shading them out and altering soil chemistry (Gill 1998). Nearly pure stands of ericaceous shrubs (*Gaylussacia*, *Vaccinium*, etc.) have also developed on cleared sites in the Pine Bush. Apparently the proximity of the cleared land to a seed or clonal source determines which vegetation type will eventually dominate.

Human activity has increased the biological diversity of the Albany Pine Bush in several ways. Many nonnative species introduced into the Pine Bush ecosystem thrive here today, and some of them compete successfully with native species that were present thousands of years ago. Pine Bush vascular plants that are not native to New York State are noted with an asterisk in Appendix B. The proliferation of plant community edges along roads, fields, lawns, and the perimeters of development projects has dramatically increased the habitat for species that prefer these transitional areas. Fire suppression in recent years has allowed the invasion of fire-prone, mesic species. This increased diversity is not necessarily healthy, as many of the new inhabitants are common species that compete with uncommon pine barrens species for space, light, moisture, and nutrients.

The role that soil disturbance has played in the development of the modern Pine Bush biota has not been thoroughly investigated. There is abundant evidence that vast areas of Pine Bush soil have been subjected to significant disturbance from plowing, mining, and bulldozing (Finton 1998). It seems unlikely, however, that 19th- and 20th-century mining of molding sands had much impact here. Although mining operations took place in Karner and West Albany, and the surrounding area apparently was thoroughly stripped of the clay-bearing sand, the wind-blown sand mantle of the Pine Bush is too thick in most places for efficient extraction of the underlying molding sand. More recent removal of dune sands for concrete manufacture has certainly had an impact on the biota. Soils in areas of the Pine Bush that were at one time farmed or cleared for construction projects have been significantly disturbed. These areas often support large populations of undesirable weedy and invasive species. Human disturbance has undoubtedly altered the soil in ways that we do not fully understand. It is unlikely that former agricultural activity has left a lasting influence on soil chemistry (Motzkin et al. 1996), but mycorrhizal activity can be significantly lowered or even halted by human disturbance of the ecosystem and its soil, especially in semiarid areas. Pitch pine seedlings on disturbed, fire-suppressed sites invaded by black locust have lower mycorrhizal inoculation rates, which might account for lower survivorship and growth rates in these areas (Gill and Robinson 1996). Soil at sites formerly

occupied by nitrogen-fixing black locust trees has elevated soil nitrogen availability, which in turn could alter the course of biotic succession (Rice and Wells 2002).

## Modern Ecological Communities

Communities are assemblages of species that coexist in the same habitat. Their characteristic vegetation usually defines them, and in most cases the dominant plants are trees. The vegetation of the Albany Pine Bush is distinguished by the widespread occurrence of dry pine, oak, and heath communities in the humid, forest climate of the eastern United States, where broadleaf deciduous forest is considered the climax formation on more favorable soils. These xeric Pine Bush communities are composed of species that can tolerate drought, fire, and soil nutrient impoverishment. Their occurrence in a deciduous forest climate probably results from the unusually sandy Pine Bush soils with low water- and nutrient-holding capacity that subject the vegetation to periodic drought and, consequently, to frequent fire. Soil nutrients are lost through leaching, runoff, convective loss of ash, and volatilization by fire. The poor soils support regrowth of pine and shrub communities susceptible to another fire (Whittaker 1998). However, the Pine Bush also supports an array of nonxeric communities.

Plant community composition in the Albany Pine Bush is affected by fire disturbance, land use history, and soil conditions (Milne 1985). It is nearly impossible to establish how much of the landscape is in a natural or near-natural state because of its long history of disturbance. Different fire and land use disturbance frequencies and intensities interrupt succession in different ways, thus accounting for much of the current variation in forest composition, and often obscuring the effects of any soil differences within the Pine Bush. Study of tree ages has shown that pitch pine occupied many upland sites in the past when few deciduous trees were present. Milne (1985) concluded that disturbance of the Pine Bush upland ecosystem has occurred on two spatial scales, with small agricultural tracts interspersed within a frequently burned matrix. Shrub dominated areas have been disturbed more recently by fire and human activity than forest areas. On formerly cleared sites in the Pine Bush, stands of black locust or aspen can develop, and so can pure stands of ericaceous shrubs. Which community develops depends on proximity of seed sources or clonal expansion rates.

The New York Natural Heritage Program has developed a classification of discrete community types that can be used as mapping units to help assess and protect the biological diversity of the state (Reschke 1990). It compiled an inventory of Pine Bush ecological communities in 1991 to assist in the development of a comprehensive management plan for the area (Schneider et al. 1991). The Pine Bush today supports at least 14 recognized community types (Rensselaer Lake and the ravine streams have not been described): pitch pine–scrub oak barrens, pitch pine–oak forest, Appalachian oak–pine forest, pine–northern hardwood forest, successional northern hardwood forest, successional southern hardwood forest, pine barrens vernal pond, rich sloping fen, shallow emergent marsh, red maple–hardwood swamp, unpaved road or path, sand mine, brushy cleared land, and landfill (Schneider et al. 1991; Mattox 1994). Most of these community types are secure throughout their respective ranges (Reschke 1990). The pitch pine–oak forest, pitch pine–scrub oak barrens, and pine barrens vernal pond communities are unique to pine barrens. The pitch pine–scrub oak barrens community is imperiled globally throughout its range, the rich sloping fen is vulnerable globally throughout its range, and the pine barrens vernal pond is uncommon and possibly vulnerable globally throughout its range (Reschke 1990).

Pitch pine–scrub oak is the dominant community type in the Albany Pine Bush Preserve, occurring primarily in the center of the Pine Bush, where fire historically posed the least threat to humans. High quality pitch pine–scrub oak barrens are concentrated in the Preserve east and west of Route 155. A significant amount of fair to poor quality fire suppressed barrens mixed with successional hardwoods is found in the central and southwest sections of the Preserve, with scattered areas in the western and southeastern section as well. Pitch pine–oak and pine–northern hardwood forests are also concentrated in the Rensselaer Lake area. Closed-canopy hardwood or pitch pine forests with emerging white pine or shade-tolerant hardwoods, such as red oak, white oak, red maple, and white ash, are common, especially in fire-suppressed areas. The most intense fire suppression has occurred on the periphery, adjacent to homes and busi-

nesses. Significant fire-suppressed portions throughout the Preserve, especially in the western section, are now dominated by black locust and quaking aspen. Other major natural communities of the Pine Bush are wetlands and ravine forests, which are not fundamentally fire dependent. Broadleaved hardwoods reach their highest densities on moist sites, where the water table is close to the soil surface. Wetlands are concentrated in the northwest section of the Preserve. They are also found to a limited extent in the eastern and southwestern section and around Rensselaer Lake.

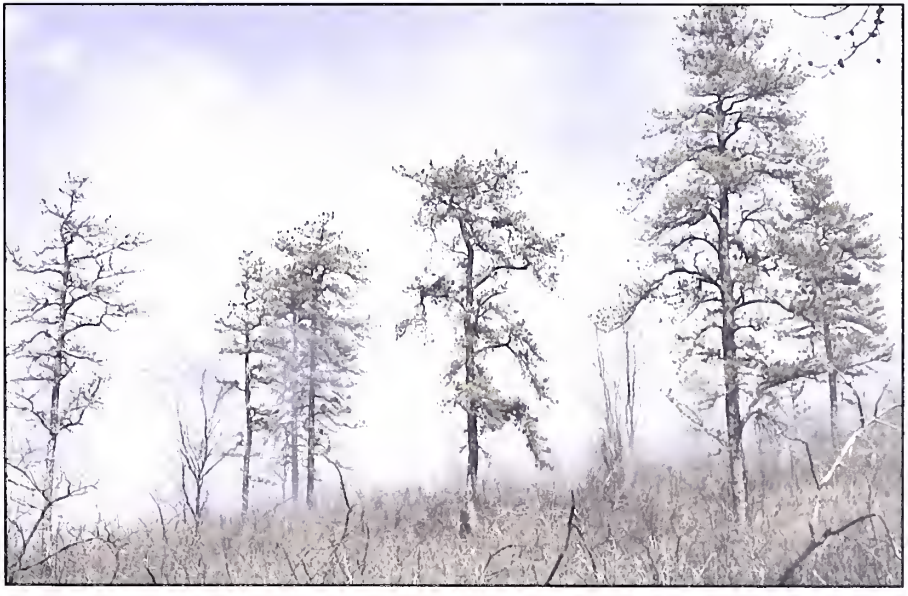
## Terrestrial Communities

Communities of the terrestrial system occur in upland areas with well-drained soils.

### Pitch Pine–Scrub Oak Barrens

From a worldwide perspective, this is the rarest of all the community types comprising the Albany Pine Bush ecosystem, and it is the main focus of conservation concerns here. Pitch pine–scrub oak barrens are found at fewer than 20 major sites in the world, mostly along the Atlantic coastal area of the northeastern United States, and at fewer than five sites in New York State, mostly on Long Island and in the Hudson Valley. This community type is sometimes called pine bush, oak brush plains, or sand plains. The Nature Conservancy refers to it as northeastern pitch pine–scrub oak barrens (Schweitzer and Rawinski 1988).

The pitch pine–scrub oak barrens community occurs on sandy, well-drained, acidic, nutrient-poor soils among the Pine Bush sand dunes. It is adapted to and maintained by fires occurring every 6–15 years. The requisite soil conditions and natural wildfires rarely occur together. In the absence of frequent fire, natural succession would probably transform this community into hardwood forest dominated by oak. The importance of fire and the role it has played in shaping the community is clearly illustrated by the diversity of adaptations to fire that many of the native plants have. Scrub oaks produce large root reserves that allow for rapid resprouting following fire. Pitch pine has thick, fire-resistant bark, epicormic buds, and an ability to resprout basally. Occurrence of the pitch pine–scrub oak community in a deciduous forest climate probably results from sandy soils with low water- and nutrient-holding capacity. Water loss subjects the vegetation to periodic drought, and consequently to frequent fires. Nutrient loss from soil supports regrowth of pine and shrub communities susceptible to another fire (Whittaker 1998).



This community type consists of a sparse canopy of pitch pine trees scattered through a thick shrubby layer dominated by scrub oaks (*Quercus ilicifolia*, *Q. prinoides*) and a low shrub layer of sweet-fern, blueberries (*Vaccinium angustifolium*, *V. pallidum*), and black huckleberry. Prairie and dune willows (*Salix humilis* var. *humilis*, *S. humilis* var. *tristis*), sand cherry, and sheep laurel are conspicuous at localized sites within the Pine Bush. Characteristic forbs include round-headed bush clover, goat's rue, and wild lupine. Bracken, little bluestem, and Pennsylvania sedge are common in pitch pine–scrub oak communities throughout the Northeast. Small grassy areas in low frost pockets undergo rapid radiational cooling at night. In spring, tender young leaves of scrub oaks growing in these depressions can be killed by late frosts. Frost pockets tend to be dominated by the prairie grasses big bluestem, little bluestem, and Indian grass. Higher grassy openings support wild lupine, blunt-leaf milkweed, butterfly-weed, bird's-foot violet, frostweed, New Jersey tea, and other xerophytic plants. In disturbed barrens or those areas that have not burned frequently in recent years, black locust, black raspberry, white snakeroot, and sheep sorrel become conspicuous members of the community. Typical birds include the pine warbler, eastern towhee, brown thrasher, prairie warbler, and common yellowthroat. The American toad, Fowler's toad, eastern spadefoot, eastern hognose snake, and common garter snake are typical of the amphibians and reptiles. The pitch pine–scrub oak community has an exceptionally rich Lepidoptera (moths and butterflies) community (Schweitzer and Rawinski 1988). Typical species include the autumn-flying inland barrens buck moth, several spring elfins (frosted elfin, eastern pine elfin, Henry's elfin, brown elfin) and dusky wing skippers, the late spring dusted skipper and cobweb skipper, the summer-flying Edward's hairstreak, the bird-dropping noctuid moth (*Cerma cora*), and another noctuid moth, *Chaetaglaea cerata*.

The pitch pine–scrub oak community is the most extensive community type in the Albany Pine Bush Preserve, and it is the main target of conservation efforts. Areas of good-quality barrens can be found to the north, east, and west of the intersection of New Karner Road and the New York State Thruway. Some of the best-quality pitch pine–scrub oak barrens remaining in the Albany Pine Bush can be found in the area known as Karner Barrens East, to the east of this intersection.

Fire suppression and clearing for development threaten the continued existence of this community. Many areas that would have been maintained by fire as pitch pine–scrub oak barrens have become later successional communities, such as northern and southern hardwoods and possibly Appalachian oak–pine forest and pine northern hardwood forests. In these later successional communities, fire is less frequent, intense, or severe. Later successional communities will encroach further on pitch pine–scrub oak communities if fragmentation of the original ecosystem continues, and as the growing proximity of urban development decreases the likelihood of uncontrolled fires.

Several regional varieties of pitch pine–scrub oak barrens have been recognized, based on the composition of both the flora and fauna. Inland pine barrens of central New York and the upper Hudson Valley (including the Albany Pine Bush), western Massachusetts, southern New Hampshire, Connecticut, and Rhode Island support colonies of wild lupine, New Jersey tea, sand cherry, and false indigo. Boreal pine barrens of northern New York, Maine, and parts of New Hampshire support various boreal herbs, but xerophytic plants such as wild lupine, wild indigo, New Jersey tea, and dwarf chestnut oak are absent. Coastal barrens of Cape Cod, Long Island, and New Jersey, with ocean-moderated climate, support many plants and lepidopterans with southern affinities, but wild lupine, New Jersey tea, and wild honeysuckle are rare or absent. A distinct race of buck moth occurs in coastal barrens. A Poconos variant of the pitch pine–scrub oak community supports fly-poison (*Amianthium muscaetoxicum*) and the sedge *Carex polymorpha*, but many barrens species, such as wild lupine, bearberry, wild indigo, and New Jersey tea, are absent (Schweitzer and Rawinski 1988).

## Pitch Pine–Oak Forest

Pitch pine–oak forest occurs fairly commonly on the sandy dunes of the Albany Pine Bush. Elsewhere in New York State, this forest type occurs on well-drained sandy soils and thin, rocky soils in the pine barrens ecosystems of Long Island and the Hudson Valley and on the rocky ridge tops of the Hudson Valley.

This community type is a mixture of pitch pine and tree oaks (scarlet, white, red, and black) in variable proportions. Quaking aspen is often present to varying degrees, and black locust becomes a prominent feature in disturbed communities. The oaks can be small and younger than the pines as a result of the oaks starting as sprouts after the last wildfire and the pines living through that and perhaps earlier fires. The shrub layer has scattered scrub oak shrubs and a cover of low heath shrubs, such as blueberries and black huckleberry. Characteristic plants of the herbaceous layer include bracken and Pennsylvania sedge. Juniper moss is often present in Pine Bush sites. This composition appears to be the logical result of both natural succession to an oak-hickory forest and periodic interruptions by heavy cuttings and wildfires. Oak-killing fires occur at intervals of perhaps 40 years or longer. Characteristic birds include the eastern towhee, common yellowthroat, field sparrow, prairie warbler, pine warbler, blue jay, and whip-poor-will.

Pitch pine–oak forest is a natural community type in the Albany Pine Bush, occurring in areas that have not burned recently.

## Appalachian Oak–Pine Forest

Appalachian oak–pine forest occurs in the steep ravines of the Albany Pine Bush, in a mosaic with pine–northern hardwood forest. In New York State, this community type occurs on well-drained sandy soils, sandy ravines in pine barrens, and rocky slopes in the Appalachian Plateau, Hudson Valley, and Taconic Highlands.

This community type is characterized as a mixed forest dominated by oaks and pines. White oak, black oak, pitch pine, and white pine predominate, and red maple and black cherry are common associates. Blueberries and huckleberries are found in the shrub layer. Species diversity is low in the herbaceous layer.

This community type historically occurred in the Pine Bush, although it may have expanded in some areas where fire has been suppressed for a long period. It is not a target of complete conversion to pitch pine–scrub oak through restoration efforts.

## Pine–Northern Hardwood Forest

Pine–northern hardwood forest occurs primarily in the ravines of the Albany Pine Bush, in a mosaic with Appalachian oak-pine. However, several acres of this community type also occur above the ravines. It is a common community that occurs on glacial sands and gravels throughout Upstate New York.

This community type is characterized as a mixed forest dominated by white pine and yellow birch, with a scattering of other trees, including basswood and red maple. Witch-hazel, white snakeroot, Pennsylvania sedge, bracken, and fancy fern (*Dryopteris intermedia*) are common in the lower layers. Pine warblers, pileated woodpeckers, and eastern box turtles are characteristic animals.

This community type historically occurred in the Pine Bush, although it may have expanded in some areas where fire has been suppressed for a long period. It is not a target of complete conversion to pitch pine–scrub oak through restoration efforts.

## Successional Northern Hardwood Forest

Successional northern hardwood forests occur throughout New York State on sites that have been cleared for farming or disturbed through logging or fire suppression. The canopy species do not reproduce. Most saplings in this forest type are of species more shade tolerant than the canopy tree species. Lower layer dominants are often species that occurred on the site prior to disturbance. In the Albany Pine Bush, this community occurs in patches throughout the dunes in former pitch pine–scrub oak barrens that have been disturbed by fire suppression.

Quaking aspen and big-toothed aspen dominate successional northern hardwood forests. Red maple, pitch pine, white pine, and black cherry are common associates. The lower layers contain blueberries and huckleberries.

This community type historically occurred in the Pine Bush, although it expanded in some areas where fire has been suppressed for long periods. It is not a target of complete conversion to pitch pine–scrub oak through restoration efforts.

### Successional Southern Hardwood Forest

In New York State, successional southern hardwood forests occur primarily south of the Adirondacks on sites that have been cleared for farming or disturbed in some other way. As in successional northern hardwood forests, the canopy species do not reproduce; most saplings in this forest type are of species more shade tolerant than the canopy tree species. Lower-layer dominants are often species that occurred on the site prior to disturbance. In the Albany Pine Bush, this community occurs in former pitch pine–scrub oak barrens or pitch pine–oak forests that have been disturbed or protected from fires.

Most successional southern hardwood forest in the Albany Pine Bush is dominated by black locust. Black cherry, black raspberry, and white snakeroot are common associates.

This community type is considered restorable to pitch pine–scrub oak barrens (Albany Pine Bush Preserve Commission Technical Committee 1996). It is expected that management tools other than prescribed burning will be needed to reduce the black locust populations. Girdling, herbicide treatment, or mechanical clearing may be necessary.

## Palustrine Communities

Communities of the palustrine system occur in wetlands and are characterized by emergent vegetation. Although the Albany Pine Bush is often characterized as warm, dry, sandy, and fire-prone, wetlands and associated plants and animals occur throughout the area. Springs, marshes, ponds, streams, and moist ravines contrast with the dry upland habitats. Pine barrens vernal ponds and rich sloping fen communities are rare in New York State and globally vulnerable to extinction.

### Pine Barrens Vernal Pond

Pine barrens vernal ponds in the Albany Pine Bush occur in depressions between sand dunes and are fed by groundwater. Water levels fluctuate with the season and tend to be lowest in mid-summer. The pine barrens vernal pond, rich sloping fen, and pitch pine–scrub oak barrens are rare community types found in the Albany Pine Bush. In New York State, pine barrens vernal ponds are known only from sandplains in the Great Lakes Plain and Hudson Valley ecozones. Similar communities occur on sandy soils in New England and New Jersey.

Sphagnum mosses, sedges, grasses, and herbaceous species dominate, often with a good representation of tussock sedge. The liverwort *Ricciocarpos natans* (L.) Corda is often observed. Characteristic shrubs include meadow-sweet, hardhack, highbush blueberry, black chokeberry, and leatherleaf. Amphibians of vernal ponds include the Jefferson salamander, spotted salamander, American toad, Fowler's toad, spring peeper, and the wood frog.

Pine barrens vernal ponds, along with pitch pine–scrub oak barrens, are primary targets of conservation efforts in the Albany Pine Bush. Surrounding development projects and consequent alterations to hydrology, especially a lowered water table, are major threats to this community type. The role of fire in maintaining this community type is not well understood. However fire suppression and invasion of nonnative species may pose dangers to the vernal pond communities. Natural succession probably would transform these communities into red-maple-hardwood swamps.

### Rich Sloping Fen

Mattox (1994) encountered a small area of rich sloping fen in the Albany Pine Bush while surveying the wetland vascular flora. This community type typically occurs on organic soils in shallow depressions on slopes composed of calcareous glacial deposits. It is usually fed by mineral-enriched water from small springs or groundwater seepage. In New York State, rich sloping fens are most often found on the Appalachian Plateau in areas with calcareous glacial deposits.

The fen community that Mattox (1994) encountered is evidently unique in the present-day Pine Bush. Small terraced pools on the slope of a low dune are kept open by powerline maintenance. The calcareous water percolating the terraced slope creates rare habitat for a sandy area. Some of the plants that occur here are calcicoles that thrive on the mineral-enriched water. The community harbors such Pine Bush rarities as *Gentianopsis crinita*, *Liparis loesellii*, *Lycopodiella inundata*, and *Platanthera psycodes*.

### Shallow Emergent Marsh

Shallow emergent marshes in the Albany Pine Bush Preserve are generally small, occurring along the small, sandy streams in the bottoms of the ravines and along the railroad in the north central portion of the Preserve. In terms of acreage, this is a minor component of the Albany Pine Bush landscape. This community type occurs on soils that are permanently saturated and seasonally flooded. It occurs commonly in lake basins and along streams throughout New York State.

Grasses and sedges, including tussock sedge and lake sedge, dominate shallow emergent marshes. Skunk cabbage and common cattails are frequent associates. Nonnative invasive plants, such as purple loosestrife (*Lythrum salicaria*) and common reed (*Phragmites australis*), are also present. Characteristic amphibians and reptiles include the American toad, spring peeper, bullfrog, green frog, northern leopard frog, painted turtle, and northern water snake. The pied-billed grebe, a transient occupant of the Pine Bush, is a characteristic bird.

### Red Maple–Hardwood Swamp

Red maple–hardwood swamp occurs in poorly drained depressions in areas of the Albany Pine Bush that have not burned recently. Over half of the limited red maple–hardwood swamp acreage here is not homogeneous. It supports a mixture of swamp and upland species. In some of the mixed areas there are small patches of pitch pine–scrub oak barrens on sandy islands. This broadly defined community type has many regional variants, and it is common throughout New York State, usually on inorganic soils.

The canopy-dominant, red maple, is often found in association with gray birch, poplars, red oak, gray dogwood, spotted jewelweed, slender mannagrass (*Glyceria melicaria*), and royal fern. Salamanders are characteristic animals.

Nearby construction projects, invasive plants, and agricultural practices could threaten Pine Bush red maple–hardwood swamps by altering the local hydrology, lowering the water table, and draining the swamps.

## Artificial Terrestrial Communities

A variety of communities has been created and maintained in the Albany Pine Bush by human activities. The biota and, often, the character of the substrate are different from those that existed naturally. Four artificial terrestrial communities are recognized here. In general, only a small acreage is occupied by each of these.

Unpaved road or path communities are sparsely vegetated areas of bare sand or gravel maintained by regular trampling along sand roads, foot trails, powerline rights-of-way, and railroad tracks. These areas host a large number of exotic, introduced plant species that threaten adjacent communities.

Sand mine communities are sparsely vegetated excavations in the sand dunes from which sand has been removed. They undergo a slow reinvasion by native and nonnative plants. For many years, such pits may bear scattered plants of sweet-fern, pitch pine seedlings, and sedges. A pine stand will probably eventually develop in the absence of nonnative plants.

Brushy cleared land communities have been clearcut, often in preparation for development projects. Vegetation is often patchy. This community type is considered restorable to pitch pine–scrub oak barrens (Albany Pine Bush Preserve Commission Technical Committee 1996).

The landfill community occurs in an area that has been cleared or excavated and then filled with organic and inorganic garbage. The Albany Landfill is significant in size, occupying well over 100 acres (40 ha). The garbage and the soils used to cap the landfill are not necessarily conducive to restoring native Pine Bush vegetation, although it may be possible to establish populations of native grasses and shrubs that can tolerate the unusual conditions.

Despite the problems associated with these artificial communities, they can be critical areas for maintaining important species that require open sand, such as the sedge *Cyperus schweinitzii*, wild lupine, and the Karner blue butterfly. Unpaved roads or paths and sand mines are especially significant in this regard. Powerline rights-of-way in the Albany Pine Bush are very useful in maintaining the open habitats needed by many characteristic pine barrens plants and animals, es-

pecially butterflies and moths (Schweitzer and Rawinski 1988). Management by mechanical disturbances that maintain open sand may be required in the future to maintain viable populations of rare and sensitive species because the natural process that used to maintain them, probably hot wildfires combined with high winds, have been permanently lost from the landscape.

## Modern Biota

The pine barrens are not really barren at all. Species diversity in the Albany Pine Bush is high. The lepidopteran fauna is exceptionally rich, and about 65 percent of the butterfly species that occur in New York State have been found in the Pine Bush (Schweitzer and Rawinski 1988; Wheeler and Wilson 1996; T. L. McCabe, personal communication). Habitats that support diverse lepidopteran faunas would be expected to support a diverse flora, because most lepidopteran immatures (caterpillars) feed on vascular plants. About 30 percent of the vascular plant species of New York State have been found the Pine Bush in the past 100 or more years (Appendix B; Mitchell and Tucker 1997). Over 40 percent of the *Sphagnum* moss species of New York State have been found growing in Pine Bush wetlands. The great diversity of life in the Pine Bush is a reflection of the ecological diversity of the area. Xeric sand dune communities abut cool ravine forests and a variety of wetland habitats. Successional forests and weedy species have become common in the disturbed landscape. The proliferation of community edges along developed land supports healthy populations of a wide variety of species that historically would not have been found here. Fire is an important force in shaping the present-day biota of the Pine Bush, but it is absent or only a minor force in surrounding ecosystems. Species that are able to survive frequent, hot fires and germinate on nutrient-deficient soils are found here, but in few other ecosystems. Fire-resistant plants, characteristic of native Pine Bush vegetation, are adapted to low-nutrient soil conditions and precede establishment of more mesophytic, invading species dependent on nutrient-rich soils. The flora is influenced by major soil differences, such as soil moisture. Land clearing for past agricultural pursuits, housing, commercial and industrial development, road building, sand mining, and other human activities have exerted strong influences on plant and animal community patterns. Disturbance has created structural diversity in the Pine Bush, allowing more species to be present. Unfortunately, when more species are present in a region of limited size, the relative abundance of critical and characteristic species must decline.

### Fungi

Many kinds of fungi, both edible and poisonous, can be found in the Albany Pine Bush. They are especially evident when the fleshy fruiting bodies, or mushrooms, appear aboveground in autumn and after heavy rains. The mycelium, which is the underground portion of the fungus, consists of an extensive network of branching strands rambling through the soil. The strands, or hyphae, that make up the mycelium can appear as fine, white threads that adhere to undersides of leaves and branches on the ground. In the soil, hyphae grow in all directions, and when they come in contact with an appropriate plant rootlet, they may form a sheath encasing the root tip. Some fungus cells penetrate between the cells of the rootlet, but do not kill it. These symbiotic fungus-root associations are called mycorrhizae. The fungi obtain sugars and moisture from the host plant. The plants are rewarded with increased underground absorbing surface, helping them to obtain nitrogen, phosphorus, and other scarce nutrients. The fungal mutualists are efficient scavengers of organic forms of nutrients, and their contribution is strongest when soil nutrient levels are low. Mycorrhizae are able to absorb nutrients from a far larger area than individual root hairs because hyphae grow and branch through a much larger volume of soil. Mycorrhizae also remain functional over extended periods of time and at varying conditions, allowing exploitation of temporary periods of increased mineral nutrient availability, such as the interval immediately following fire.

Mycorrhizal fungi are widespread, and they comprise a major biomass component of many terrestrial ecosystems. Certain plants would not thrive in the sand and poor soils of the Pine Bush if it were not for mycorrhizae. These associations between plant and fungus species are often quite specialized, although some fungi can form mycorrhizae with several different plant

species. Most plants have a wide variety of fungal partners and most fungi have multiple hosts. Many boletes (mushrooms with pores instead of gills) occur in association with pitch pines. Pitch pine seedlings on fire-suppressed sites invaded by black locust have lower mycorrhizal inoculation rates, which might account for lower survivorship and growth rates in these areas (Gill and Robinson 1996). Nitrogen, phosphorus, potassium, and calcium deficits in soils and plants seem to favor mycorrhizal formation (Buchholz and Motto 1981).

The Albany Pine Bush is very important to the study of fungi, the science of mycology. From collections made here, many species new to science were first described and named, including the culinary delicacy known as the narrow stemmed morel (*Morchella augusticeps*). The Pine Bush is therefore the important type locality for each of these species. It was a favorite collecting ground of Charles Horton Peck, a State Museum scientist, State Botanist of New York from 1867 to 1912, and an eminent pioneer mycologist. Of the nearly 3,000 species of fungi he named as new to science, more than 100 were first described from the Pine Bush. Homer D. House, another State Botanist at the State Museum, in cooperation with John Dearness, a Toronto-area teacher, later described and named several more fungi from Pine Bush type specimens (Dean 1976). Rittner (1979a) compiled an extensive list of fungi collected and described from the Albany Pine Bush during the 19th and early 20th centuries.

## Lichens and Bryophytes (Mosses, Liverworts, Hornworts)

Little is known about the lichen flora of the Albany Pine Bush, although lichens are common here. A preliminary list of lichens found from 1867 to 1977 was compiled by Milne (1979).

Bryophytes are common in the Pine Bush, yet floristically and ecologically they are little known. A preliminary list of bryophytes is given in Appendix A of this volume. In the pine barrens of New Jersey, bryophyte and lichen cover are higher than in surrounding regions, although diversity is lower. It has been found that cover increases with fire frequency, but diversity of bryophytes decreases. The increase in cover is related to the burning of litter and the subsequent increased availability of mineral soil for bryophyte growth. When leaf litter is deposited, bryophyte mats die. Bryophyte cover also increases with soil moisture (Forman 1998). Bryophytes and lichens play an important role in intercepting and retaining rainwater. Mosses are known to efficiently intercept nutrients contained in precipitation. They can prevent rapid leaching of nutrients to lower horizons of the soil. In view of its storage capacity, the moss carpet can act as a reservoir in which a large proportion of the potentially available nutrients found in the ecosystem is sequestered. The rapid colonization of fire moss (*Ceratodon purpureus*) after disturbance can help prevent soil erosion. The abundance of this moss after disturbance promotes a large accumulation of organic matter, which favors the development of invertebrate fauna.

### The Pine Bush Bryophyte Flora

*by Norton G. Miller and Lorinda Leonardi, New York State Museum*

The predominantly sandy habitats of the Albany Pine Bush may not appear to be especially rich in bryophytes, at least when compared to upper slopes of Adirondack and Catskill mountains and other places in New York where the forest floor is an almost continuous green cover of moss and liverworts. However, despite the inconspicuous nature of Pine Bush bryophytes, it will surprise many that this area supports a large number of species, even though the plants are patchy and discontinuous in their distribution. We have observed and documented 99 mosses, 20 liverworts, and 1 hornwort in various places in the Pine Bush. These totals represent about 20 percent of the bryophyte flora of New York State (Miller and Mitchell 1995).

The Pine Bush appears to contain no bryophyte species that are unique to pitch pine–oak barrens, even though this distinctive vegetation is widespread but of scattered

*continued*

### The Pine Bush Bryophyte Flora, *continued*

occurrence in the northeastern United States. The Pine Bush bryophyte flora for the most part consists of common species that occur widely in the Northeast. However, the Albany Pine Bush is special because it contains a diversified group of distinct vegetation types in a small area. This heterogeneous landscape supports many more species than do areas of comparable size elsewhere, particularly those that are ecologically uniform. A significant variety of bryophytes is found in these Pine Bush vegetation types: pitch pine–oak associations; secondary deciduous forest; ravines and stream headwaters in deciduous forest; fossil dune areas with deciduous or mixed pitch pine–deciduous forest (especially bryophyte-rich north-facing dune slopes); peaty fen wetlands and adjacent thickets; swamp forests; and ponds and pond margins. Pine Bush wetlands (mostly fens and sedge marsh) contain 21 species of *Sphagnum* moss, 42 percent of 50 species known from New York State (Andrus et al. 1994). Nearly all sites supporting bryophytes in the Albany Pine Bush are acidic, and commonly encountered substrata include sandy soil, rotting logs, *Osmunda* hummocks, and the bases and boles of deciduous trees. Typical habitats and substrata for Pine Bush bryophytes are listed in Appendix A.

A few bryophyte species of special interest grow in the Pine Bush. These are the liverwort *Lejeunea ulicina*, collected once on a rotting log in a ravine, known only from one other place in New York (the Finger Lakes region), and a great rarity in the Northeast; *Plagiothecium latebricola*, another rarity, a moss found in the Pine Bush on the sides of peaty hummocks at the margins of shallow ponds; and *Sphagnum platyphyllum*, an uncommon peat moss of sporadic occurrence in New York (only three other stations known) and the Northeast.

## Vascular Plants

The pine barrens flora of the Albany Pine Bush was characterized in foregoing discussions as well adapted to an arid, fire-swept, acidic, nutrient-poor, excessively drained land. Pine barrens usually have an open canopy of pitch pines and an understory of scrubby oaks and heaths. Pine barrens plants often have deep roots, leathery leaves, or other characteristics that help them to cope with dry conditions. Root associations with symbiotic fungi or bacteria help them survive on the nutrient poor soils. Thick bark, an ability to resprout, rapid early growth, dormant seeds, and many other characteristics enable these species to endure in the face of frequent fire.

Botanists have long recognized that the Pine Bush seems to harbor some species more typical of the Atlantic Coastal Plain to the south or the prairies of the Midwest. In his *Catalogue of the Flowering Plants of Schenectady County*, E. W. Paige (1864) remarked on the southern floristic elements he found in the "Pine Plains"—elements that exist nowhere else in the state, except on Long Island. The prairie grasses found in the Albany Pine Bush are perhaps an anomaly, persisting here from warmer periods when the surrounding landscape was treeless and ecologically similar to the prairies of the central states. Their spotty distribution in the Pine Bush seems to indicate that they are not particularly adapted to present conditions. In general, they prefer calcareous soils, and calciphiles are not uncommon in the Pine Bush. The sands might be alkaline or less acidic in certain localities due to prehistoric influences from the limestones of the Helderberg Escarpment or marbles of the Adirondacks.

The oaks, genus *Quercus*, deserve special mention because of their importance in the Pine Bush ecosystem, especially in the barrens communities. In general, they are tolerant of dry conditions, and they resprout well after fire has destroyed aboveground tissues. Eight species of *Quercus* are recorded from the Pine Bush. Two species, scrub oak and dwarf chestnut oak, have a shrubby growth habit. They are the dominant shrubs in the pitch pine – scrub oak community, and they also occur in the pitch pine – oak forest, successional northern hardwood forest, in sand mines, and on brushy, cleared land. The other six are trees. Of them, red oak (*Q. rubra*), black oak (*Q. velutina*), white oak (*Q. alba*), and chestnut oak (*Q. montana*) are important com-

ponents of Pine Bush forest communities.

Two distinct subgroups of *Quercus* are recognized. Pine Bush species in the red oak group, including red oak (*Q. rubra*), black oak (*Q. velutina*), scarlet oak (*Q. coccinea*), and scrub oak (*Q. ilicifolia*), have pointed, and often bristle-tipped, leaf lobes, bitter and inedible acorns that mature after the second growing season, and a velvety layer between the acorn seed covering (not the cup) and the seed. Pine Bush species in the white oak group, including white oak (*Q. alba*), swamp white oak (*Q. bicolor*), chestnut oak (*Q. montana*), and dwarf chestnut oak (*Q. prinoides*), have rounded, unbristled leaf lobes and, often, relatively sweet and palatable acorns that mature after a single growing season. They lack a velvety lining of the seed covering. A fifth species in the white oak group, the calciphilic chinquapin oak (*Q. muhlenbergii*), may occur here, but its presence has not been confirmed by botanists. Unfortunately, oaks can be notoriously difficult to identify because of their propensity for hybridizing. Among the white oaks listed here, the following hybrids have been recognized: *Q. alba* × *prinoides*, *Q. alba* × *bicolor*, *Q. alba* × *montana*. Among the red oaks, these hybrids have been recognized: *Q. coccinea* × *velutina*, *Q. coccinea* × *ilicifolia*, *Q. ilicifolia* × *rubra*, *Q. ilicifolia* × *velutina*, *Q. rubra* × *velutina*. Only *Q. alba* × *bicolor* has been reported from the Pine Bush, and its presence has not been confirmed in recent years. The Pine Bush oaks require more attention from professional botanists.

The oaks are important to Pine Bush wildlife. The foliage and some other parts provide sustenance to a wide variety of moth and butterfly caterpillars, gall-forming wasps, plant- and leafhoppers, and other insects. The acorns are a concentrated source of fat, carbohydrates, and vitamins. Acorns are consumed or gathered by wildlife so quickly and efficiently that it is nearly impossible to find a mature acorn in the pitch pine–scrub oak community in autumn. Those that can be found are often infested with grubs of acorn weevils. Many species of birds and mammals consume oak mast. Blue jays are perhaps the most effective dispersers of oaks. They can carry away thousands of acorns per bird in a season, burying them in scattered caches, often long distances from the point of origin (Johnson and Webb 1989; Johnson et al. 1997). Wild turkeys have been found to have large numbers of acorns in their guts. Deer consume red and white oak acorns. Chipmunks can consume half a dozen or more acorns per day, and white-footed mice take their share. Fire prunes the scrubby oaks and tends to increase acorn production (Miller and Lamb 1985; Opler 1974).

Broadleaved hardwoods dominate the mesic ravine forests of the Albany Pine Bush, which are not fire-prone. White oak, black oak, pitch pine, white pine, red maple, black cherry, yellow birch, and basswood are frequently encountered here. In the vernal ponds and marshes, tussock sedge, grasses, and herbaceous species dominate. Characteristic shrubs of vernal ponds include meadow-sweet, hardhack, highbush blueberry, black chokeberry, and leatherleaf. Red maples dominate the swamps. During intensive field surveys conducted over the 1992 and 1993 growing seasons, Mattox (1994: Figure 3) located 155 obligate or strongly facultative wetland vascular plant taxa, nine of which had not been previously recorded from the Pine Bush.

Pine Bush vegetation clearly shows the effects of human disturbance. Upland areas have a long history of disturbance by fire suppression, clearing, cultivation, and development. Wetland hydrology has been altered by various human influences, including drainage for agriculture and development. Several nonnative and invasive native plants thrive in the Pine Bush as a result of landscape disturbance. About one-quarter of the vascular plants recorded from the Pine Bush are considered nonindigenous introductions (Appendix B). Black locust, quaking aspen, and bigtoothed aspen are particularly aggressive trees that can outcompete native plants, jeopardizing habitats of endangered species and the long-term viability of the ecosystem. A strategy of combined mechanical and chemical treatments might help to control these species and restore native pine barrens species to more than 700 acres (283 ha) currently dominated by invasive species (Gifford 1998). Because of fire suppression in the wetlands, invasive tree species, including gray birch and quaking aspen, and an invasive shrub, meadow-sweet, are gaining ground over native herbaceous wetland species. Naturalized species, including common reed (*Phragmites australis*) and purple loosestrife (*Lythrum salicaria*), are invasive in some of the shallow emergent marshes. Water-chestnut (*Trapa natans*), moneywort (*Lysimachia nummularia*), ground-ivy (*Glechoma hederacea*), and garlic mustard (*Alliaria petiolata*) are common in places and pose a threat to native plants (Mattox 1994).

Botanists, both professional and amateur, have long cherished the Albany Pine Bush. In the 1830s, James Eights, a noted Albany naturalist, published his botanical observations in an Albany journal of science, literature, and arts entitled the *Zodiac*. Edward Paige (1864), a Schenectady native and New York City lawyer, authored the 1864 *Catalogue of the Flora of Schenectady County*. Charles Horton Peck, State Botanist of New York from 1867 to 1912, and Homer House, State Botanist at the State Museum from 1913 to 1949, made extensive collections of plants. House's assistant, Elsie Whitney, collected plants in the Pine Bush in the late 1920s and early 1930s. From 1938 to 1941, Alice Mary Ritter surveyed Pine Bush plants for a Cornell University master's thesis (Ritter 1941), and in the 1940s and 1950s a Schenectady resident named Theodore Baim collected plants near the Karner railroad station. In the 1950s, Malcolm McDonald, a professor at Union College, Schenectady, surveyed plants and deposited his specimens in the New York State Museum. Stanley Smith, a botany curator at the State Museum from 1947 to 1978, collected plants and kept extensive records on file at the Museum. Rittner (1976a) compiled a list of nearly 1184 taxa (species, subspecies, varieties, hybrids) of Pine Bush vascular plants from these records. In more recent years, several individuals affiliated with the New York State Museum, the New York Natural Heritage Program, and area colleges and universities have contributed to our knowledge of Pine Bush floristics. Schneider et al. (1991) reported on rare sedges and grasses from the Pine Bush, and Mattox (1994) surveyed the wetland vascular flora. University at Albany botanist George Robinson has reviewed and updated Rittner's list of Pine Bush vascular plants (Appendix B).

The checklist of Pine Bush vascular plants now totals more than 1,200 taxa (species, subspecies, varieties, hybrids). At least 60 percent of these have been sighted in recent years. Nearly 50 species are probably extirpated. Forty-two species are now considered imperiled in New York State. Thirteen imperiled species have been found growing in the Pine Bush in recent years; 10 others are probably locally extinct. Many lost and imperiled species are associated with wetlands or open sand habitats. Habitat loss, fire suppression, alteration of hydrology, herbivory, competition from invading species, recreation pressures, and unmanaged collecting have played roles in the decline of these Pine Bush plants and animals (Mattox 1994). The role of fire in maintaining the Pine Bush wetland flora and fauna is unclear (Schneider et al. 1991).

In their inventory of the rare plants, animals, and ecological communities of the Albany Pine Bush Preserve, Schneider et al. (1991: Appendix A) identified five vascular plant species that probably no longer grow here. Chaffseed (*Schwalbea americana*) is known in New York State only from the Pine Bush, and it has not been found here since 1865. False gromwell (*Onosmodium virginianum*) and the sedge *Carex cumulata* have not been found here since 1919. Woodland agrimony (*Agrimonia rostellata*) was last observed in 1927. Tick-clover (*Desmodium ciliare*) also has disappeared from the Pine Bush. Mattox (1994: Figure 3, pages 54–67) found historical records of 238 vascular plant species, 8 subspecies, 16 varieties, and 3 hybrids characteristic of wetlands. During 1992 and 1993 field surveys, she (Mattox 1994: Figure 4, pages 68–87) was unable to locate 92 taxa growing in the Pine Bush. Of these, 25 percent had not been seen in the Pine Bush since the 19th century, and another 25 percent were last seen during the 1900–1950 interval. Most of these 46 species are probably extinct locally. Many extirpated species once grew at the Poplar Street Bog. The rare Pine Bush bog habitats have been lost to suburban development. Other wetland species are very local in occurrence, existing as only single populations or as very few scattered populations in the Pine Bush. Several imperiled Pine Bush wetland plants, such as the sedges *Cyperus erythrorhizos* and *Scirpus georgianus*, and the grass *Poa paludigena*, could be threatened by development and alterations to regional hydrology (Schneider et al. 1991). The annual red-rooted flatsedge, *Cyperus erythrorhizos*, is associated with pine barrens vernal ponds. Georgia bulrush, *Scripus georgianus*, was last collected in the Pine Bush in 1964 (Mattox 1994). The imperiled slender marsh bluegrass, *Poa paludigena*, occurs on wet, mucky soil at the bottom of a ravine in a pine–northern hardwood forest. Changes in hydrology of wet ravines could eliminate this species.

Three sedges of open sand are vulnerable to extirpation in New York State. The Houghton umbrella sedge, *Cyperus houghtonii*, thrives in disturbed, open sand and perhaps benefits from tree falls and shifting, wind-blown sand. The rusty flatsedge, *Cyperus odoratus*, prefers moist or wet soils of low areas. In the Pine Bush it is found on disturbed, open sand near the railroad

tracks. The vulnerable Schweinitz sedge, *Cyperus schweinitzii* Torrey, occurs in sand mines and along unpaved sandy paths (Schneider et al. 1991). Loss of open sand habitats is also contributing to a severe decline in wild lupine and its associated insect fauna.

Plant species vary greatly in their capacity to persist and recruit new individuals in habitats that burn repeatedly. Three categories of plant responses to fire are commonly recognized (Whelan 1995). Fire ephemerals are pioneer species, such as aspen and birch, which disperse into a site after fire. Sprouters, such as the shrub oaks of the Pine Bush barrens communities, survive fire and regenerate from dormant buds. Nonsprouters, or seeders, die in a fire, and then the species reestablishes from seeds stored in the soil or on the plant. Many species use a combination of strategies. Pitch pine uses both sprouting and seeding strategies to survive frequent fire.

Dormant buds of sprouters can be located in different plant parts in different species, and they are usually insulated from the heat of fire by thick bark or by soil. Soil is a good insulator, and tissues located only a short distance below the surface are well protected from the rising heat of a flame. Small and young plants of otherwise thick-barked species are more susceptible to fire and tend to be killed along with the thin-barked species. Some species can sprout only when they are relatively young. Buds, called epicormic buds, are sometimes located on aboveground plant parts, as in pitch pine. More typically, fire-tolerant plants resprout from buds at the base of the stem (caudex), at the root crown, or on underground rhizomes. Suckering from horizontal rhizomes can produce large clonal populations, a common occurrence in trembling aspen. In grasses, the new developing tissues of meristems are located at the leaf bases, insulated from the upward-directed heat of fire by densely packed stems and leaves in a grass clump or tussock. Sprouters often are late to seed, they produce small seed crops, and they have reduced seedling growth rates.

Other plant species characteristic of fire-prone communities are thin-barked, lack protected dormant buds, and are killed by fire. They cannot resprout, but their fire-resistant dormant and dehydrated seeds persist in the community as a seed bank. Seed banks are often further protected from fire by burial in soil (fire-cherry), enclosure within insulated fruits or cones (pitch pine) in the plant's canopy, or by being borne high in the canopy. Many different cues help to synchronize seed release and germination to the creation of a postburn environment. Nonsprouters depend on fire to stimulate reproduction, and they can be driven to extinction if fire is suppressed. Young nonsprouters often have growth and reproductive advantages over sprouters.

Fire or smoke can directly stimulate flowering, seed release, or germination from the dormant seed bank. In some species and in some communities (e.g., pitch pine in the dwarf pine plains of Long Island and New Jersey), dispersal of canopy-stored seeds is delayed until the canopy burns, when they are finally released as a group. This condition, known as serotiny, seems to evolve when stand-killing crown fires burn over extensive areas, fire interval is too short for much reproduction to occur from plants establishing between fires, and fire size is too large for significant seed dispersal from adjacent unburned area. Open-coned, weakly serotinous pitch pine variants are associated with the low frequency, less-intense fires of the Albany Pine Bush.

Germination in some species is stimulated by increased water absorption resulting from the heating of impermeable coats of dormant seeds. Hard-seededness, which is broken by heat, occurs in several families of plants, including Fabaceae, Rhamnaceae, and Cistaceae. Dormancy in legumes is broken by heat rupture of the lens, a specialized part of the seed coat. Once the lens is ruptured, water can enter the seed and germination can begin. Heat-stimulated germination of legumes can fail if fires are of low intensity.

Fire can stimulate flowering and germination indirectly by altering local environment and preparing the seedbed. Increased resources, and perhaps chemicals in smoke, stimulate some species to bloom after fire. Bare mineral soil exposed after fire has burned away the litter is favorable for germination of many Pine Bush species. The heavy acorns of oaks eventually fall between dead leaves and contact mineral soil, where they can sprout and produce new oaks, but light pitch pine seeds suspended on dry leaf litter cannot germinate. Fire gaps in the plant community often have increased sunlight, warmer soil, more water, and more nutrients. For many plant species, the open space, increased availability of resources, and temporary reduction in seed predators are highly favorable for germination and seedling establishment in the postfire environment.

## Insects and Other Arthropods

Although there has been an increasing appreciation of northeastern pine barrens as communities that support an exceptionally rich insect fauna, especially butterflies and moths, our knowledge of pine barrens arthropods in general is sparse, even for the better known areas, such as the New Jersey Pine Barrens. The structure of the unusual and diverse Albany Pine Bush arthropod community is largely controlled by the structure of the unusual plant community. Many Pine Bush herbivorous arthropods feed mostly on oaks and pines or depend on other species of the unique, fire-adapted plant community, such as the rapidly declining wild lupine. For example, many longhorned beetles (Coleoptera: Cerambycidae) specialize in using the wood of living or dead pines or oaks. The oaks support a vast array of caterpillars and gall wasps. Black cherry feeds caterpillars of several dozen species of butterflies and moths, and the aspens support more than 50 species of butterflies and moths (Tietz 1972). In fact, among the families of larger moths, over 75 percent of all species known from New York State have been recorded from the Albany Pine Bush (T. L. McCabe, personal communication). Predatory arthropods, especially ants and spiders, are abundant. As in other terrestrial pine barrens habitats, oribatid mites are probably the major animal decomposers, complementing the more important decomposition role of the fungi (Dindal 1998). In studies of the New Jersey Pine Barrens soil microarthropod community (Buffington 1967; Dindal 1998), oribatid mites were found to dominate in all types of sites, regardless of the dominant vegetation. Many decomposer scarab beetles were also present in the litter. Predators were diverse, with litter dwelling ants and spiders prevalent. Some insects, such as the tiger beetles and the bombyliid flies that pursue them, and the ant lions, are especially well adapted to life in warm, dry, sandy, habitats.

The oaks, with many long-lived and widely distributed species, support a vast array of insect species. The immense insect communities associated with oaks include borers, sap-feeders, foliage chewers, leaf-miners, and gall-makers. Oak-feeding caterpillars are abundant in spring, providing food for many species of birds. According to Ephriam Porter Felt (1940), State Entomologist at the New York State Museum from 1898 to 1928, oaks support the largest and most interesting gall insect fauna. Gall wasps of the family Cynipidae are restricted to a great degree to the oaks, but the great number of species and their remarkable abundance belie this limitation. All parts of the oak are affected: roots, bark, trunk, branches, twigs, leaves, buds, staminate and pistillate flowers, and acorns. The different species of insects that feed on a single oak are able to coexist because they occupy different niches. Different species specialize in feeding on different parts of the plants, or perhaps the same parts at different times, or different areas of a leaf or other plant parts.

The rich mirid plant bug fauna (Hemiptera: Miridae) of scrub oak consists of predaceous and phytophagous species, including early season specialists on staminate catkins. It seems that scrub oak harbors a richer plant bug fauna than many tree oaks. However, in the Albany Pine Bush, Wheeler (1991) collected only 9 of the 44 species known to occur on scrub oak in northeastern pitch pine–scrub oak barrens. He feels that more will be found when greater collecting effort is made. Three rare mirid plant bugs associated with scrub oak in northeastern pitch pine–scrub oak barrens (*Pilophorus furvus* Knight, *Schaffneria davisi* Knight, and *S. schaffneri* Knight) are rather ant-like in appearance, and they are found only in or near aphid colonies tended by the ant *Dolichoderus taschenbergi* (Mayr). These Batesian mimics presumably gain protection from their resemblance to the ants. So far, none of these three mimic species have been reported from the Albany Pine Bush, but the ant species does occur here. Pine barrens planthoppers (Homoptera: Fulgoroidea) are also diverse, and five species collected consistently from scrub oak and pitch pine in northeastern pine barrens can be considered characteristic of these insect-rich natural communities (Wheeler and Wilson 1996).

The Albany Pine Bush ant fauna is generally similar to that of the coastal pine barrens, but at the present time it seems to be significantly less diverse. The list of ant species presently known from the Pine Bush comprises 33 named and described species and two *Myrmica* species that are new to science and do not yet have valid names. Harvard University ant specialist Stephan Cover (personal communication) feels that there are probably 10 to 15 additional species that thorough collecting will reveal over time. The Pine Bush ant fauna might seem small in part because of the small size of the area relative to the other barrens. Conspicuously absent from the

Pine Bush is a group of species characteristic of sandy, pine-dominated habitats of the Southeast. These species reach their northern limits in a series of disjunct occurrences in the New Jersey, Long Island, and Massachusetts pine barrens. Pine barrens ant faunas tend to be somewhat more diverse than those of adjacent habitats, perhaps because these areas tend to be warmer. The distinctive element in any pine barrens ant fauna is comprised of open-ground species that depend on fire to keep woody vegetation in check. If fire is suppressed too long, these species die out and are replaced by a woodland fauna that is little different from that of adjacent oak forest.

Entomologists have long appreciated pine barrens as communities that harbor an exceptionally rich lepidopteran fauna, including numerous species that do not occur in nearby deciduous forests. In 1877 an Albany physician and lepidopterist named James S. Bailey described the Albany Pine Bush as having a worldwide reputation botanically and entomologically (Bailey 1877). Collecting was usually confined to a thousand-acre tract at Center, New York (renamed Karner after 1880), midway between Albany and Schenectady. Two daily trains allowed collectors to explore the area during the first half of the day. Among entomologists, the area was informally known as "Butterfly Station." Joseph Albert Lintner (1889), New York's noted State Entomologist, once referred to the Pine Bush as "perhaps the most noted insect hunting-ground of the northern United States." It is perhaps odd that aside from his cherished Karner blue butterfly, lepidopterist and novelist Vladimir Nabokov found here nothing else of popular or scientific interest (Nabokov and Bruccoli 1989: Letter to Patricia Hunt, 6 February 1951). Rittner (1979b) listed insects recorded in the literature of the late 19th and early 20th centuries. Bailey (1877) and Hill (1882) had listed some Lepidoptera collected at Center. However, the main authors of the literature reviewed by Rittner are Lintner and his successor as State Entomologist, Ephraim Porter Felt. Together they described more than 70 new species from Pine Bush specimens, and so the Pine Bush is historically and scientifically significant as the type locality for many insect species. Tim McCabe, New York State Museum, published lists of longhorn beetles (Cerambycidae) (McCabe and Huether 1986) and caddisflies (Trichoptera) (McCabe 1980, 1986). Because of the Pine Bush's reputation as a fine collecting ground for entomologists during the 19th century, we have a good basis for comparing today's insect fauna with the assemblage of species that occurred in the Pine Bush a hundred years ago. McCabe (1993, 1995) compiled a list of historic insect collecting records for the Albany Pine Bush and Long Island barrens. He analyzed it to identify a list of 32 potential pine barrens specialist species (including 6 species that seem to occur only in the Albany Pine Bush), and a list of 30 insect species that have disappeared from the Albany Pine Bush. (Schneider et al. [1991: Appendix B] listed 44 species of Noctuidae [Lepidoptera] that McCabe and Dale Schweitzer considered to be pine barrens specialists, and [Appendix C] 25 species of Lepidoptera that are probably extirpated from the Albany Pine Bush.) The status of Albany Pine Bush species of Asilidae (Diptera), Cicindelidae (Coleoptera), and

Lepidoptera is clear from an examination of the revised lists presented in this volume (Appendix C).

Of the 30 or more species of butterflies, moths, and skippers that have become locally extinct during the past century, 5 species (*Poanes viator, Darapsa versicolor, Agroperina lutosa, Eugraphe subrosea*, and *Argyrostrotis quadrifilaris*) are wetland associates (*A. quadrifilaris* was collected in 1879, then again in 1995) (McCabe 1995). In addition to these, Lintner's bog skimmer, the dragonfly *Williamsonia lintneri* (Odonata: Libellulidae), originally described from two Pine Bush specimens collected around 1878, has never again been recorded from the wetlands of its fragile type locality, and it is believed extirpated from the Albany Pine Bush. The Pine Bush has suffered severe loss and disruption of wetlands. Many other extirpated species were at their northern or southern range limit in the Pine Bush. Species at the periphery of their ranges may not be reliable indicators of habitat quality because their ranges can fluctuate naturally. It is best to study the decline of characteristic pine barrens species on a case-by-case basis. The effects of the decline of the wild lupine are especially evident in the condition of the lepidopteran fauna that specializes on this food source. The Persius dusky wing skipper, *Erynnis persius*, was last reported from the Albany Pine Bush in the late 1970s, even though the Pine Bush is well within the range of this species (McCabe 1993). The threatened frosted elfin, while still present in the Pine Bush, has become quite rare and declines with every loss of lupine habitat. The Karner blue butterfly is now protected as an endangered species under both state and federal statutes. Among non-lupine-dependent Lepidoptera, the magnificent regal fritillary, *Speyeria idalia*, is declining throughout its range, and it no longer adorns the Pine Bush. At least one local food plant of its caterpillars, bird's-foot violet, has become a rare sight in the Pine Bush. The noctuid moth *Anomogyna badicollis* no longer inhabits the Pine Bush. Its food plant, young pitch pine, is becoming increasingly rare as deer browse it and seeds fail to germinate or seedlings are unsuccessful in competing with weedy species. Another once-common noctuid, *Homohadena badistriga*, has not been seen in the Albany Pine Bush since 1988. Its caterpillars prefer wild honeysuckle, *Lonicera dioica*, but so do the whitetail deer. Inchworms of *Semiothisa eremiata* are no longer found feeding on the sparse patches of goat's rue. The giant silk moth, *Citheronia sepulcralis*, whose larva, known as the pine devil, feeds on pitch pine, has disappeared from the Pine Bush. Its spectacular relatives, the regal moth or royal walnut moth (*Citheronia regalis*) and the imperial moth (*Eacles imperialis*) both began to disappear from New York State around the middle of the 20th century, apparently due to pesticide spraying for the gypsy moth, an introduced and highly destructive forest pest.

In addition to the butterflies and moths that have disappeared from the Albany Pine Bush landscape, at least 14 rare species are at precariously low population levels here (Schneider et al. 1991; Environmental Design and Research, P.C. 1993). Major threats seem to be habitat loss due to urban development; habitat loss due to fire suppression and subsequent unchecked succession; insecticide use, especially broadcast spraying for gypsy moths; and the many competing nonnative species that have been introduced inadvertently (McCabe 1995). Most of the imperiled insects are associated with communities that burn periodically. The noctuid moth *Chaetaglaea cerata* lays eggs on scrub oak in autumn. The eggs winter over, and the larvae that hatch in spring feed on new oak buds (Schneider et al. 1991). Today this species hangs on precariously in an area adjacent to the current Albany city landfill. Some species, such as the Karner blue and frosted elfin butterflies, are imperiled primarily because their food plant is in decline as a result of fire suppression. The inland barrens buck moth and dusted skipper (*Atrytonopsis hianna*) also require habitats that burn frequently. Schneider et al. (1991) reviewed several other species of moths and butterflies thought to be Pine Bush rarities. The list includes a geometrid moth in the genus *Itame*, and the noctuid moths *Polypogon martha, Cerma cora, Acronicta albarufa, Chytonix sensilis, Apharetra dentata*, and *Macrochilo bivittata*. It also includes the butterflies *Satyrium edwardsii* (Edwards' hairstreak) and *Incisalia henrici* (Henry's elfin). Most of these species are rare in New York State outside the Pine Bush, and some have not been seen here either in recent years. Five of the 10 insects that appear on New York State's official list of endangered species (Karner blue, regal fritillary, Persius dusky wing, Arogos skipper, and pine pinion moth [*Lithophane lepida*]), 1 of the 5 threatened insects (frosted elfin), and 4 of the 15 insect species of special concern (Henry's elfin, tawny crescent, mottled dusky wing, and barrens buck moth) have been recorded from the Pine Bush (see Appendix C). Undoubtedly many species in poorly

studied groups of insects that are less showy than butterflies and moths also have been lost from the Pine Bush fauna or are imperiled here.

The insect community is in some ways less resilient to environmental threats than the plant community. For example, many plants persist under less than ideal circumstances for years or decades after fire suppression has led to crowded or shaded conditions that halt successful reproduction. Some Pine Bush plants, such as wild lupine, can also persist for long periods as dormant seeds buried in the soil. However, most Lepidoptera and other insects are eliminated by only one season without successful reproduction. Recolonization on sites from which they have been eradicated is a function of distance to the nearest source of colonizers, the size of the source population, and the size of the barrens to be recolonized. Because the Albany Pine Bush is a long distance from the nearest source of potential colonizers, and it is rather small, the chance of natural recovery for an extirpated species seems very small (Schweitzer and Rawinki 1988).

Each of the thousands of arthropod species inhabiting fire prone communities of the Albany Pine Bush responds to fire in a characteristic way. The vast array of life history strategies among arthropods spawns myriad responses to fire in the community. It seems that few arthropods, other than those inhabiting cool soil layers, can survive fire in place. When fire passes through the community, arthropods are killed directly, or they survive by moving away from the burning area, or they remain in place and escape the devastating effeets of fire through some behavioral strategy. Fire also affects insects by altering soil properties, vegetation, tree density, and other habitat factors. Insects in fire-prone communities often have strategies for surviving fire or recolonizing burned areas. Many factors interplay to determine whether or not burned communities recover, and the pace at which recovery proceeds. Much is known about how the vegetation of the Pine Bush is affected by fire and then reestablishes itself after fire, but much remains to be learned about arthropod responses.

Experimental data suggest that fire strongly suppresses arthropod abundance and diversity initially. Many arthropods, especially those with poor powers of flight, cannot survive fire. Food supplies and shelter are also lost in fire. Populations of flightless surface-dwelling arthropods, such as beetles, springtails (Collembola), mites, spiders, and others that live in flammable litter or vegetation, are drastieally reduced by fire, and it takes time for them to reinvade afterwards (Buffington 1967; Dindal 1998). Leafhoppers, aphids, and planthoppers that winter as eggs inserted into the aboveground tissues of plant hosts, and parasitoid wasps that winter as larvae or pupae in dead plant stems, can be destroyed by fire (Harper et al. 2000). Soil arthropod groups, especially predators, decrease in diversity with increasing fire frequency, and annual burning is especially detrimental to all soil arthropod groups. On the other hand, in some exceptional instances, flying insects are attracted by heat, smoke, or killed or damaged trees, and populations of these species can increase during and after fire. Some wood borers have infrared receptors on their legs that enable them to orient directly to radiant heat from a fire, while others can orient to the smoke emitted by fires. A few species can survive in place, protected from fire by insulating soil or plant tissue. Species with cryptic habits—those living inside unburned logs and those living underground (such as ants)—may be able to survive the fire itself, but they will be faced with an altered landscape after the fire. Some insects survive fire by moving to unburned refuges, into the canopy, into grass tussocks, animal burrows, or other protected places; after the fire passes, they recolonize burned patches. Some species avoid fire by avoiding mature vegetation with a dry fuel load that is likely to burn, favoring instead the more produetive, open, recently burned vegetation (McCullough et al. 1998).

Fire can alter soil properties, remove litter and vegetation, and affect other aspects of the habitat. The postfire environment is hostile to many arthropods because of the scarcity of food and lack of cover from predators, but it is favorable to other species because of stimulated postfire plant growth. The loss of living plant tissue and decaying litter reduces the food supply and shelter available for arthropods. Predators and parasites that depend on these arthropods are also impacted. By reducing plant litter and humus, fire opens the soil to sunlight and evaporation. Species unable to tolerate xeric conditions suffer from exposure to greater extremes of temperature, light, and moisture.

Populations of some insects increase after fire. Ants are less affeeted by fire than many other

groups of insects, because their cryptic habits enable them to survive in the soil below the level of intense heat, they tolerate xeric postfire conditions, and their colonization habits and social organization enable them to rapidly reestablish on burned land. In the New Jersey Pine Barrens, *Solenopsis molesta*, an ant species that also occurs in the Albany Pine Bush, was strikingly more numerous on burned land than on unburned land. The success of this species is related to a preference for xeric conditions and a dry-seed hoarding habit (Buffington 1967). Fire can make trees susceptible to attack by insects, particularly bark beetles and wood borers (Buprestidae and Cerambycidae). Some Lepidoptera, notably the inland barrens buck moth, increase in abundance for several years in response to luxuriant postfire growth of host plants (Schweitzer and Rawinski 1988). The underground buck moth pupae survive fire. The species requires large stands of young or resprouting scrub oaks to sustain a long-term population. Elongated stems and young leaves typically occur after fire. Collembola diversity and populations sometimes increase after fire, probably because of increased soil fertility, and some highly vagile prairie leafhoppers are attracted to lush green postfire vegetation (Harper et al. 2000; Kalisz and Powell 2000; Metz and Dindal 1975). Karner blue butterflies, which have no known specific adaptations that assist them in surviving fire, must have a supply of wild lupine in order to survive. Wild lupine is dependent on fire keeping the canopy open so it can grow and multiply.

Postfire differences in insect community composition can be temporary or ongoing. Species endurance is influenced by numerous factors, including severity of the fire, postburn vegetation, distance to refuges, and the relative mobilities and fecundities of the affected species. In general, abundance and species richness tend to recover quickly through recolonization from adjacent unburned areas. Some species, such as the less mobile aphids, require more time to recolonize, despite an abundance of suitable host plants.

Fire suppression efforts initiated around the turn of the century have profoundly altered species composition and structure of many northern forests (McCullough et al. 1998; Whelan 1995). These stands are often significantly more vulnerable to insect pests, and the intensity of outbreaks and degree of damage caused by the insect pests can be dramatically increased. Pest outbreaks can result in sudden accumulation of dry, flammable biomass. State Entomologist J. A. Lintner (1889) reported more than 100 years ago that the orangestriped oakworm (Saturniidae: *Anisota senatoria*), which had been so excessively abundant that all the smaller oaks in the Pine Bush were defoliated, was now far less apparent due to fires that had repeatedly swept through the area and "banished the superabundance of insect life." In some situations, prescribed burning can successfully control insect pests, especially those that spend part of their life cycle in vulnerable stages on the ground.

Management of insect populations in the Pine Bush has received little consideration. Aside from the Karner blue butterfly, inland barrens buck moth, and a few other butterflies and moths (Schweitzer and Rawinski 1988; Schneider et al. 1991), few other insects have received management attention. Management practices that promote a diverse arthropod community are important because arthropods are the dominant component of terrestrial biodiversity, and they play crucial roles in nutrient cycling, pollination, and other ecosystem functions. Responses to management techniques remain largely unknown for most arthropod communities. Research work is needed to elucidate the effects of prescribed burning on the natural arthropod community and its potential for control of pest outbreaks. Information on arthropod ecology and life history, lacking for many species, could allow managers to predict responses to fire. However, arthropod populations have innumerable sources of variability that could confound attempts to make such predictions. For example, the response of a particular plant-feeding insect species to fire may depend as much on the effects of the fire on its predators, pathogens, parasitoids, and host plants as it does on the direct mortality effects of the burn on its own population. Arthropod populations often undergo significant natural fluctuation from year to year, and significant changes in arthropod species composition due to management effects may not become apparent for many years following the onset of a particular management program.

Above all, long-term monitoring is needed to accurately assess the effects of prescribed burning and other management techniques on the arthropod community. Monitoring of arthropod faunas should begin before management practices are initiated. Populations of many Pine Bush arthropod species probably are substantially reduced by prescribed fire. Survival of many

arthropod species could hinge on development of management strategies that maintain native vegetation while avoiding harm to resident arthropod populations. The assumption that management with prescribed fire benefits native insects by restoring their habitat, especially the vegetation, has been questioned by some entomologists, who have noted marked declines in insect abundance in areas recently burned (Dindal 1998; Swengel 1996). There is reason for concern over possible long-term, detrimental effects of prescribed burning on populations of insects restricted to isolated, remnant communities such as the Albany Pine Bush. There are no refuge areas nearby that harbor pine barrens arthropods and might serve as sources for recolonization. Frequent burning of an entire isolated, remnant preserve such as the Pine Bush could cause local extinction of some arthropod populations. To preserve the native arthropod faunas, land managers should ensure that sites managed with fire are divided so only a portion is burned at a time, thus providing unburned refuges within the Pine Bush, and that intervals between burns are sufficient to allow recolonization of burned areas to occur.

## Amphibians and Reptiles

The Albany Pine Bush is home to only about one-quarter of the amphibian and reptile species that inhabit the surrounding area. Protective crevices are scarce because rocks and fallen logs are in short supply, even in ponds and streams. The exposed sand surface is hot and dry, and the thin covering of leaf litter that might offer some shelter is frequently destroyed by fire. While turtles use the dry, upland woods for feeding and breeding grounds, toads and snakes survive the Pine Bush heat by burrowing into dunes or seeking shade beneath discarded trash. Efforts to clean up trash without substituting natural cover now destroy a great deal of remaining habitat (Stewart and Rossi 1981; Stewart and Ricci 1988).

However, beneath the dry surface of the Pine Bush the water table tends be fairly high. Many ground-dwelling species are able to survive in areas where the water table lies near the surface or intersects the surface and forms seepages, ponds, or streams. Depressions in the topography can become moist pockets or temporary ponds favored by toads, frogs, and other moisture-loving animals. Seepage areas are fairly common, providing relatively permanent water supplies for certain salamanders and frogs. When the increased use of water from wells lowers the high water table characteristic of the pine barrens, wetlands do not form, and breeding sites disappear. Vernal ponds, needed for reproduction of such species as the long-absent tiger salamander and other amphibians, have become scarce, and habitat has disappeared with artificial lowering of the water table.

Thirty-three species of amphibians and reptiles have been recorded from the Albany Pine Bush since the early 1950s (Appendix E). The most common species are the spring peeper, green frog, eastern American toad, wood frog, gray treefrog, northern leopard frog, and the northern redback salamander. These species are also common elsewhere in Albany County. Remarkably, seven native species recorded in the Pine Bush are not known from elsewhere in Albany County: eastern spadefoot, Fowler's toad, spotted turtle, eastern box turtle, eastern worm snake, black rat snake, and eastern hognose snake. For the most part, these are burrowing species, or they have other adaptations that provide them with fire and drought tolerance. The eastern spadefoot, Fowler's toad, and the eastern hognose snake prefer sandy soils for burrowing. Until recently, the Pine Bush also provided habitat for the rare eastern worm snake, found under debris in moist areas near streams. The northern black racer may also have disappeared from the Pine Bush in recent years. The eastern American toad and eastern garter snake are frequently encountered in the pitch pine–scrub oak community. The toads tend to breed in temporary ponds located in open areas. Jefferson salamanders, blue-spotted salamanders, wood frogs, and spring peepers tend to prefer ponds near wooded cover. Northern dusky salamanders, northern two-lined salamanders, and northern leopard frogs prefer the permanence of seepages and streams. Other amphibians and reptiles found in the Pine Bush are broadly tolerant species that are found throughout the Northeast.

The amphibian and reptile fauna of the Albany Pine Bush is also remarkable because this ecosystem is at or near the periphery of many species' ranges. For several Pine Bush species, the Hudson Valley region, a corridor of warmer climate between colder surrounding highlands, is a

northern projection from the main body of a more southern range. These species include the eastern spadefoot, Fowler's toad, eastern box turtle, spotted turtle, eastern worm snake, eastern hognose snake, black rat snake, and northern black racer. The Pine Bush is at the northernmost edge of the eastern worm snake's distribution, and it is the northern limit for the eastern hognose snake in the Northeast. It is the northernmost limit of the range of Fowler's toad in New York State. The eastern spadefoot does not occur north of the sandy soils of Albany, Schenectady, and Saratoga Counties (Stewart 1976; Stewart and Rossi 1981). It was recently recorded from Wilton Wildlife Preserve and Park in Saratoga County (Tierney and Stewart 2001).

Previously unrecorded species of amphibians and reptiles continue to show up in the Pine Bush from time to time. The red-eared slider, a turtle commonly sold in pet shops, is not native to the Pine Bush. It was found in Six Mile Reservoir in 1976. More than 20 years ago, Stewart (1976) predicted that certain bog relicts, such as the four-toed salamander, spotted turtle, and bog turtle, might occur in the Pine Bush. The spotted turtle was recorded soon thereafter (Stewart and Rossi 1981). The common musk turtle was found in the Pine Bush in 1995 (Hunsinger 1999). The smooth green snake was recorded for the first time in 1999 (R. J. Gill, personal communication).

However, the historical record shows a general decline in the amphibian and reptile fauna over a period of many decades. The five-lined skink, *Eumeces faciatus* (Linnaeus), has not been reported from the Pine Bush, but its distribution projects northward from the main body of its range to include Schenectady, Warren, and Washington Counties. It is possible that it once occurred in the Pine Bush, but that it disappeared before 1800. James Eights, an Albany naturalist, found the eastern box turtle and spotted turtle to be common in the Pine Bush (Eights 1835, 1836), but they were not recorded again until Stewart and Rossi's (1981) survey in the mid 1970s. At least one species, the eastern tiger salamander, *Ambystoma tigrinum* (Green), has disappeared completely since the early 1800s (Stewart and Rossi 1981). The black rat snake was last found in the Pine Bush in the early 1950s. The eastern worm snake and northern black racer, which have not been seen here since the survey of Stewart and Rossi (1981), might be extirpated from the Pine Bush (Hunsinger 1999). None of the seven native Pine Bush species that are not found elsewhere in Albany County (eastern spadefoot, Fowler's toad, spotted turtle, eastern box turtle, eastern worm snake, black rat snake, and eastern hognose snake) is particularly abundant, and their numbers appear to be on the decline. Schneider et al. (1991) identified the Jefferson–blue-spotted salamander complex, eastern spadefoot, spotted turtle, and eastern hognose snake as rare Pine Bush amphibians and reptiles. Some of these suffer from loss of wetland habitat. The eastern hognose suffers from human persecution due to its defensive behavior, which involves imitating the actions of a cobra. Attempts were recently made to evaluate the feasibility of reintroducing the eastern box turtle, a former resident of the Pine Bush not seen here in several years. Reintroduction efforts were abandoned, however, because of the relocated adults' tendency to wander extensively.

## Birds

With its superabundant insect life and abundant mast and berry production, it is not surprising that the Albany Pine Bush is teaming with bird life. For example, the common, noisy blue jay, a signature Pine Bush species, relishes the plentiful acorns of the oak and pine woods. However, the Pine Bush also provides important habitat for a number of declining scrub-breeding bird species that are of local or regional conservation concern. Although birds are abundant and diverse, and evidence indicates that the avifauna is of statewide significance, current information on Pine Bush birds for the past 20 years was seriously deficient until Brian Beachy of the University at Albany conducted an extensive survey in the summer of 2001 (Beachy 2002; Beachy and Robinson 2002). Ornithologists and casual birdwatchers enjoy the great variety of bird life found in the Albany Pine Bush, but no attempt is being made to study the bird community in an ongoing, systematic way. Many records are old and replete with anecdotal material that may or may not be reliable. We do not have details about Pine Bush nesting success of bird species of concern. A challenge is thus made to the local birding community, in association with the Pine Bush Preserve Commission, to monitor the bird life of the Pine Bush and produce a continually updated, systematic, documented survey.

One hundred fifty-nine species of birds have been recorded from the Albany Pine Bush, including a little over a third of New York State's 242 breeding bird species (Appendix F). Nine former summer residents and one former year-round resident species were not observed in the summer 2001 survey. The current list of birds that are thought to breed in the Pine Bush includes some 85 summer and year-round (permanent) resident species. The list of permanent residents—the 28 species that are believed to live here all year and breed in the Pine Bush—includes many species common to suburban areas of the Northeast, such as the blue jay, cardinal, crow, house sparrow, and starling. Visitors to winter feeding stations include the black-capped chickadee, mockingbird, white-breasted and red-breasted nuthatches, and downy woodpecker. Seasonal changes in the Pine Bush bird community are marked. Among the 57 migratory species that spend the summer and perhaps breed in the Pine Bush are the bluebird, catbird, cowbird, grackle, kingbird, oriole, phoebe, red-winged blackbird, and robin. Another 42 nonbreeding species are classified as spring and/or fall transient birds of passage (Andrle and Carroll 1988; Eaton 1910–1914).

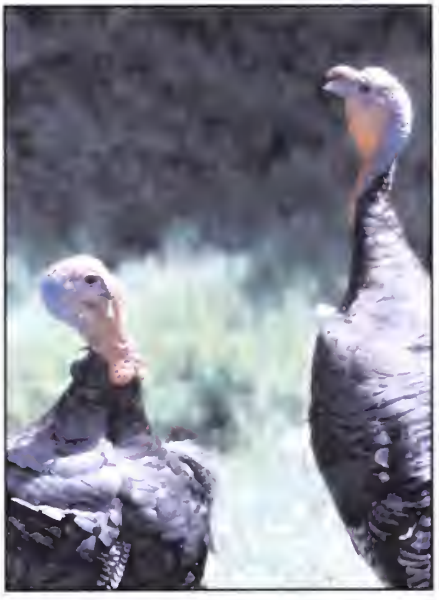
Characteristic birds of pitch pine–scrub oak barrens include the eastern towhee, common yellowthroat, field sparrow, prairie warbler, house wren, brown-headed cowbird, indigo bunting, brown thrasher, blue jay, ovenbird, pine warbler, and whip-poor-will. The pine warbler (in mature, well-spaced pines) and pileated woodpecker are characteristic birds of pine–northern hardwood forest. The chestnut-sided warbler and yellow-bellied sapsucker (in mature aspen forests) are characteristic of the successional hardwoods communities. Other species commonly seen in the Pine Bush are the gray catbird, American robin, song sparrow, American crow, red-tailed hawk, mallard, ruffed grouse, eastern kingbird, white-breasted and red-breasted nuthatches, red-winged blackbird, house finch, and American goldfinch.

Major changes in the structure of the bird community have come about due to reduction in size of available habitat, dissection of the habitat into ever smaller and discontinuous parcels, fire suppression, and invasion by deciduous trees. Disturbances have left small tracts of barrens bounded by habitats less suitable as breeding areas for characteristic pine barrens birds, such as the prairie warbler, brown thrasher, ovenbird, and pine warbler. Comparisons with past breeding bird data indicated that three species (prairie warbler, ovenbird, brown thrasher) had declined in density and range in the Albany Pine Bush by the 1980s (Kerlinger and Doremus 1981a). It also seemed that the pine warbler and eastern bluebird no longer bred here (Kerlinger and Doremus 1981b), although both have recovered, perhaps due to Pine Bush conservation efforts, but also due to recent range expansion (pine warbler) and nest box programs (eastern bluebird) (Beachy 2002). It seems that the chipping sparrow also underwent a period of decline and subsequent recovery. It was present throughout the 2001 breeding season, although 20 years earlier Kerlinger and Doremus (1981a) did not report it. The yellow-breasted chat, vesper sparrow, yellow warbler, and golden-winged warbler were not noticed in the 2001 survey, although they had been recorded in previous surveys. The absence of the golden-winged warbler is not surprising because of its recent declines across much of New York State. Brown-headed cowbird, common yellowthroat, field sparrow, house wren, gray catbird, northern oriole, indigo bunting, song sparrow, chestnut-sided warbler, and American robin have become more numerous as ecotone or edge habitats have proliferated. Predation and parasitism rates can be high in disturbed habitats. Brown-headed cowbirds, domestic cats, and chipmunks probably impact survival of some native bird species.

The 2001 survey (Beachy 2002; Beachy and Robinson 2002) found that changes in plant composition and vegetation structure caused by the invasion of black locust and aspens might be contributing to alterations in avian communities in the Albany Pine Bush. Three bird species not previously reported as breeders in the Albany Pine Bush were found in the spring and summer of 2001. Two of these species, the blue-winged warbler and hooded warbler, are undergoing range expansions, but the breeding presence of the hooded warbler and blue-headed vireo could also be related to invasion of the Pine Bush by deciduous tree species. The veery, a bird of damp, deciduous woods, was not recorded as a Pine Bush breeding bird prior to 1981. The fact that it has been breeding here for at least 20 years may be related to increased deciduous forest habitat provided by invading black locust and aspen tree. Characteristic Pine Bush birds, such as prairie warbler and field sparrow, were found only in barrens and thickets, while pine warbler

was found only in pitch-pine-dominated forests. Another characteristic species, eastern towhee, was found in all surveyed habitats, but in lower abundance in areas dominated by black locust and aspen. Chestnut-sided warbler was often associated with younger stands of black locusts and aspens, rather than closed-canopy forest. Birds found primarily in locust- and aspen-invaded areas, such as rose-breasted grosbeak and red-eyed vireo, are regional forest generalists.

Adult birds in most cases can probably escape fire, but nests, especially those constructed near the ground, may be destroyed. Fires can rejuvenate decadent stands for nesting and food production by stimulating growth of food plants and creating edges to increase nesting habitat for some species. They can also reduce parasites such as ticks and lice. Fires that reduce understory vegetation and litter can be expected to result in increased populations of birds that forage in open areas, such as eastern bluebirds, chipping sparrows, and common nighthawks; decreased populations of species that forage in dense scrub, such as brown thrashers and eastern towhees, and little change in populations of species that forage in areas not greatly affected by surface fires, such as pine warblers, woodpeckers, and gray catbirds.



*Courtesy Paul E. Meyers*

In earlier times Pine Bush game birds were important sources of food for local residents. Indians and colonists hunted ruffed grouse, bobwhite quail, and wild turkey. An unconfirmed report of a hen turkey calling in the spring of 1975 led to a prediction that it would again inhabit the Pine Bush. Today the wild turkey has made a spectacular comeback from extirpation and is now commonly found in the Pine Bush, where opportunities to view the bird are many, and the chance to hunt is also available. On the downside, anecdotal evidence points to the possibility that the surging numbers of turkeys are turning every leaf in the litter and seriously depleting the seed bank for native Pine Bush plants. The extinct heath hen was formerly common in open scrub oak and pine barrens on Long Island, but disappeared in the 1830s or 1840s. It also possibly occurred in the Albany Pine Bush, although definite evidence is lacking. The extinct passenger pigeon was a familiar Pine Bush bird until the late 1800s. It occurred by the "thousands" near Albany in the 1830s.

## Mammals

The known Pine Bush mammal fauna consists of 39 species (Appendix G). The list includes no mammals that are considered rare or endangered statewide or nationally. However, some species are rarely seen or seem to be quite rare in the Pine Bush. Mammals tend to be secretive, feeding and hunting mostly at night, and they tend to be quiet and cryptically colored. Secretive, nocturnal habits make it difficult to assess current status accurately for many species. Other species, such as the eastern chipmunk, red and gray squirrels, white-tailed deer, and cottontail rabbits are common and diurnal, and they are likely to been observed by visitors to the Pine Bush. Some species, such as the conspicuous black bear, visit only rarely, and sightings are likely to receive media attention.

In the early 1980s the deer population started to grow quite large and troublesome, especially for local farmers and homeowners, whose cultivated plants the deer find attractive. By consuming acorns and overbrowsing shrubs and saplings, deer may be preventing normal regeneration of the Pine Bush ecosystem. Deer, in fact, will eat just about any plant they can reach that is not

*Courtesy Paul E. Meyers*

poisonous or covered with thorns. Small, fenced areas, known as deer exclosures, have been placed in various locations throughout the Pine Bush. The differences between vegetation inside and outside these exclosures are dramatic and obvious to even the nonscientist, illustrating how deer can prevent regeneration of pitch pines and modify the understory. Outside the exclosures, repeated browsing of small pitch pines has produced bushy, dwarf trees with short, thick trunks. New pitch pine seedlings are almost nonexistent, a problem perhaps caused not only by overbrowsing, but also by seed consumption by mice and the growing turkey population, and by a paucity of exposed mineral soils needed for germination.

There are many reasons to be concerned about dense deer populations in the Pine Bush. Any significant amount of browsing on wild lupine could be disastrous for the endangered Karner blue butterfly. Anecdotal evidence indicates that deer show a preference for lupine inflorescences. Repeated browsing, year after year, could seriously interfere with natural reseeding. However, many lupines tend to increase under intensive grazing, so it seems that deer, rabbits, and other animals probably are not responsible for the decline of wild lupine in the Albany Pine Bush. A relationship has been observed between the abundance of deer and the abundance of deer ticks, the vectors of Lyme disease in the eastern United States. Because of the proximity to suburban areas, gun hunting is not a viable population control alternative in the Pine Bush. Although bow hunting is allowed in the state wildlife management unit that includes the Pine Bush, there are only limited areas in which legal hunting can be practiced. The New York State Department of Environmental Conservation has liberalized its deer hunting regulations to allow more harvesting of antlerless deer in this area.

Early records from the Town of Guilderland indicate that at one time gray wolves (*Canis lupus*) were common. At an April 1808 town meeting, a resolution was adopted offering a bounty of $5 to any person killing a wolf running wild within the town. There is documentary evidence that one was killed in the town on December 27, 1813. At the April 1814 town meeting, the bounty was increased to $25 (Brinkman 1945). With the local extinction of the wolf, its niche was first filled by feral domestic dogs, and later by coyotes that invaded from the west (R. Kays, personal communication).

Suspicions have been raised that domestic cats, especially feral individuals that live and hunt in the wild, might play a destructive role in Pine Bush ecology. However, it appears that feral cats are uncommon here, perhaps because of the presence of coyotes, although tame house cats that wander and hunt outdoors are prevalent in and around the Pine Bush. A recent New York State Museum survey of homes bordering the Preserve found that about a third of the 300 or so cats in the area hunt outdoors. Small mammals, such as mice and shrews, comprised the largest proportion (85%) of cat prey. Photographic surveys, radio tracking, and observation revealed that, although they can be efficient predators of small mammals, house cats rarely venture more than 16 feet (5 m) from their yards into adjacent Pine Bush. However, coyotes are rare in the smaller fragments of forest that persist in some housing developments, and cats often have the run of these small, isolated forests. It appears that cats are not an important ecological force in the large forest fragments of the Albany Pine Bush Preserve, but they may have an effect in the smaller forests in surrounding developments (R. Kays, unpublished data).

The Pine Bush hosts a number of species of small and rarely seen mammals, including two

shrews, two moles, four bats, two jumping mice, and four weasels and relatives. An unpublished study conducted in the late 1980s by the New York State Museum confirmed the presence of most of the small mammals.

Fire usually benefits small mammals or causes only temporary declines in populations. Small mammals often survive fire by moving into underground burrows or by moving to unburned areas in ravines. Concentration of small mammals into unburned patches increases vulnerability to predators. Fire mortality within burrows is difficult to assess, but it is thought to be low. In some instances, small mammals leave the burned area immediately after a fire, possibly due to the presence of loose ash, a lack of food, or the lack of cover and increased exposure to predation. As cover and food resources recover from fire, mammal abundance may be higher than before the fire and higher than on adjacent unburned areas. Recently burned areas often support increased numbers of insects and seeds of annual plants, which are beneficial to deer mice. Berry-producing shrubs important to small mammals often increase in cover and vigor after low-severity fire. Many small-mammal populations increase rapidly in response to an increase in food availability subsequent to burning. Predatory mammals should benefit during the first few years following fire due to the increased populations of small prey species. Studies have also shown that, in general, whitetail deer forage more frequently on burned sites than adjacent unburned sites. Patchy burns that create a mosaic of browse and cover are usually beneficial to whitetail populations (Whelan 1995).

# Human History in the Albany Pine Bush:

# Exploitation, Conservation, and Management

## Exploitation

The fact that the Albany Pine Bush remained essentially undeveloped throughout most of history may be surprising, given that this open land is located between two of America's oldest cities, Albany and Schenectady. Although the dry, infertile soils and fire-prone vegetation made the area inhospitable for agriculture and homesteading, the barrens have been by no means free of human exploitation. Human activities have had a profound impact on the natural history of the Albany Pine Bush. Fires ignited by Indians and later by Europeans no doubt transformed the vegetation. Indian hunting groups exploited the Pine Bush as far back as 10,000 years ago. Dutch settlers arrived in the Albany area in the early 1600s and soon developed a successful fur trade with the natives. The Pine Bush provided an overland portage route to trapping and hunting grounds of the Mohawk Valley. Transportation routes that developed through the Pine Bush facilitated trade, travel, and military activities on the western frontier of a young and developing nation.

The Pine Bush provided fuel wood, lumber, and tar from the earliest days of European settlement. Late 18th- and 19th-century developments in industry and transportation, including glass manufacturing, steam-powered riverboats and trains, and cast-metal manufacturing, called for additional exploitation of timber and sand resources. For a quarter century, from 1850 to 1875, the vast Pine Bush aquifer was tapped to supply the water needs of the vibrant and growing industrial city of Albany. Fire suppression became part of the national consciousness early in the 20th century, and soon the Pine Bush was a safer and more desirable place for human habitation. Modern roads made most of the area more readily accessible than did the old, infrequent trains running between Albany and Schenectady. Unrestrained commercial and residential development in the middle of the 20th century scarred the long-wild nature of the barrens, and much valuable habitat for rare and unusual plants and animals was lost. Water pumped from wells may have lowered the water table and caused the loss of rare pine barrens wetlands. With the elevation of the nation's environmental consciousness in the 1970s, the remaining Pine Bush habitat became the target of a successful conservation campaign. Today it is a site of vibrant conservation and restoration efforts, and it is being managed for low-impact, open-space recreation.

## Hunting, Farming, and Settlement

Paleoindians probably hunted caribou in the Pine Bush 10,000 years ago. Later, Archaic-Period hunter-gatherers and Late Woodland-Period Indian groups used local resources to advantage. In more recent times, the Mohawk tribe of Iroquois Indians, who had a reputation for being fierce and aggressive, lived in the Mohawk Valley to the west of the Pine Bush. Schenectady is a Mohawk name that, roughly translated, means "beyond the opening," probably referring to the Pine Bush. The Mahicans lived along the Hudson River, to the east. The rarity of Pine Bush cultural remains of these peoples may be accounted for by the area's status as something of a no-man's-land for the conflicting Mohawks and Mahicans (Ritchie 1976). Native Americans burned the Pine Bush to manage game, increase sources of food for gathering, or other purposes (Day 1953; Pyne 1982; Ritchie 1976; van der Donck 1968).

In 1609 English mariner Henry Hudson, engaged by the Dutch East India Company to find a Northwest Passage to the Orient, sailed up the Hudson River in his vessel, the *Half Moon*, to the vicinity of Albany, where his party found potential for a lucrative fur trade with the Indians. In 1621 the West India Company, which was incorporated by the States-General of the Netherlands to share world trade with the East India Company, was granted monopolistic trade privileges in America. It soon founded the North American colony of New Netherlands (later New York) and cultivated relations with the fur-trading natives. In 1624 the Dutch established Fort Orange, a

fur-trading post, in New Netherlands at the site of present-day Albany. Settlement of New Netherlands was slow, so in 1629 the Dutch West India Company adopted a patroon system to encourage colonization. Under this system, company members who established settlements could obtain large, heritable tracts of land. The first partoon, Killian van Rensselaer, was a diamond merchant and director of the West India Company. He selected for the Manor of Rensselaerwyck nearly three-quarters of a million acres of land on the east and west banks of the Hudson River, north and south of Fort Orange, and bought title to the tract from the Indians. Of course the Pine Bush was in the Manor of Rensselaerwyck. Patroon Van Rensselaer had the right to trade in everything except furs, which were reserved for the West India Company (McEneny 1981).

By the time New Netherlands was seized by England and renamed New York in 1664, only about 8,000 Europeans populated it. In 1686 Gov. Thomas Dongan chartered the City of Albany and established its boundaries as a long, narrow strip extending northwest from the Hudson River. This configuration gave Albany access to Pine Bush resources and control of the valuable trade route, the King's Highway, leading to Schenectady. It kept the Albany fur trade out of the jurisdiction of the surrounding Manor of Rensselaerwyck. The first European settlers in the vicinity of the Pine Bush appeared about 1700. They leased lands along the banks of the Normans Kill, which served as a route for boat traffic. Higher lands were later cleared for wheat growing. The first farms in the area were stocked and leased to the settlers by the patroon for tithes of one-tenth of their income. Prior to the Revolutionary War, there were fewer than 150 families in Rensselaerwyck on the west side of the Hudson River. Peter Kalm, a Swedish botanist and student of Linnaeus, visited the Hudson Valley in 1749 and noted the scarcity of settlement. However, he found the wheat flour from the valley the best in North America, and he reported that timber was cut and shipped down the Hudson in vast quantities. By 1788 other arrangements were being made with Rensselaerwyck farmers for permanent leases, which demanded annual payment of a patroon's rent of, say, 15 schepels of wheat, four fat fowls, and one day of service with team and wagon at the Manor House in Albany. The population of the Hudson Valley grew rapidly after the Revolution, but by 1825 there were still only a few scattered farms in the Pine Bush. They were not spaced close enough to destroy the wild nature of the area. Discontent with farm rents around 1840 led to the patroon's decision to sell land for moderate prices to the farmers. Productive farms were rapidly improved, but the unproductive farms of the Pine Bush were eventually abandoned. Theophillus Roessle's successful Pine Bush market garden operation of the 1860s, noted for its celery and fruit trees, was a notable exception (Brinkman 1945; Howell and Tenney 1886; O'Callaghan 1850; Rittner 1976c).

## Trade Routes and Transportation Corridor

Fort Orange was the most successful fur-trading center in North America during the 17th and 18th centuries, shipping more than 40,000 furs annually to the Netherlands. Native Americans, who journeyed 10 or 20 days or more from the interior, where they hunted beaver, carried furs down the Mohawk Valley over a series of trails through the Pine Bush. The quick profits that could be made in the fur trade drew the attention of farmers and craftsmen who had been induced to settle in the area. Illegal bush-runners, or "boschloopers," attempted to intercept the trade by meeting the Indians in the Pine Bush, causing much consternation with Dutch fur traders (Rittner 1976c; van der Donck 1968).

In 1661 Schenectady was founded on the Mohawk River northwest of Fort Orange, and in 1663 part of the Great Iroquois Trail was widened to allow wagons and sleighs passage through the Pine Bush between Fort Orange and Schenectady. When the English took control of the area in 1664, they named this 16-mile (26-km) road the King's Highway (Rittner 1977). It would eventually play a major role in shaping the settlement of New York State. Most of the few early Pine Bush dwellings were situated along this road. Some pioneers operated public houses, such as the Truax and Verreberg Taverns, providing lodging and refreshments to travelers.

During the 17th and 18th centuries, a valuable inland trade route of streams, rivers, and lakes connected Oswego on the Great Lakes with the Albany river port via the Pine Bush. The British and French, and later the British and Americans, struggled for control of this route. The King's Highway played an important role in military campaigns as the transportation link for soldiers

traveling up the Hudson River from New York City to the Mohawk Valley. To get around the falls at Cohoes, where the Mohawk drops into the Hudson, they had to disembark in Albany and travel by land on the King's Highway to Schenectady before proceeding to their western destinations on the Mohawk River. Between 1690 and 1760, the English provinces were under threat of attack by the French or their Indian allies. Passengers on the King's Highway were in constant danger of ambush and scalping. Fear of traveling the road did not subside until after the American Revolution. The Mohawk-Oneida waterway, via the Pine Bush, was the only feasible means of access to the Great Lakes region in the decades following the Revolution. The St. Lawrence River remained under British control.

Further settlement and development of areas to the west was facilitated by new roads leading from the King's Highway. The Schoharie Valley was opened for settlement by Palatine Germans, who had come to the area early in the 18th century to extract turpentine and tar from Pine Bush pitch pines. When this project failed, they fled to the Schoharie Valley. The Old Schoharie Road, which ran from Albany, through the Pine Bush, to Guilderland, then through the Helderbergs to Schoharie, was opened midcentury. Guilderland, Guilderland Center, and other towns grew up along it. The Albany Glass Works, one of the first post-Revolutionary War industries, was built on this road in the mid 1780s.

The King's Highway continued as a significant route until the turnpikes, canals, and railroads of the early 1800s made it faster and easier to travel west. After the Revolutionary War, national interest turned to internal improvements. One great objective was to connect existing highways with the Mohawk River, extend trade to new places, and bring products from west of Schenec-

tady to Albany, and then to market in New York City (Howell and Tenney 1886). The Mohawk-Oneida waterway was improved in the late 18th century with canals and locks. Heavy wagons loaded with goods from the West formed lines on the old Pine Bush overland connection to Albany. In 1793 a weekly stagecoach began running through the Pine Bush, charging passengers three cents per mile. In 1797 the Albany and Schenectady Turnpike (Route 5) was incorporated. This improved toll road replaced the King's Highway as the commercial link between the Hudson and Mohawk Rivers. For another century and a half, the Pine Bush would be lost in the shadows as obscure backwoods, dismal and forlorn in the eyes of progressive Americans. Today the paved King's Road follows the route of the old King's Highway for about 5 miles (8 km), running from Old State Road to Schenectady, and an unpaved section of the Highway also still exists. In 1799 construction of the Great Western Turnpike (U.S. Route 20) was started. It eventually carried the bulk of traffic between Albany and Buffalo, and it brought increased prosperity and population to the Guilderland area. Taverns sprang up at short intervals to serve emigrants going west and to funnel droves of livestock to eastern markets (Brinkman 1945; Gregg 1951).

Roads were supplemented with canals and railroads. Completion of the Erie Canal in 1825 precluded the need to skirt around Cohoes Falls by carrying goods overland from the Hudson to the Mohawk. The first railroad incorporated in the United States was the Mohawk and Hudson, chartered by the state in 1826. It began operation on September 12, 1831, running 16 miles (26 km) southeast-northwest from Albany to Schenectady and bisecting the Pine Bush (Howell and Tenney 1886). In 1847 its name was changed to the Albany and Schenectady Railroad. It was the origin of the New York Central, first link in the great line of railroads extending from the navigable waters of the Hudson to Lake Erie. In 1843 first-class trains left Albany twice daily, and an emigrant class train left once each day. One-way fare was 50 cents for first class, and 31 cents for emigrant class (Anonymous 1843). By the middle of the 19th century, plank roads were built in the vicinity of Guilderland, and soon the Hudson and Saratoga (later West Shore) Railroad was running a line from the Albany and Susquehanna Railroad north and south at almost the center of Guilderland (Gregg 1951). Karner, located at the intersection of Karner Road and the former Penn Central (now Conrail) railroad tracks, was once a whistle stop on the New York Central Railroad between Albany and Schenectady. Until around 1880, it was known as Center or Center Station. Two daily trains stopped here during the warm months, providing access to the Pine Bush for recreation and collectors of scientific specimens of plants and insects. Bailey (1877) described the area as "not in the least attractive, consisting of but a few dwellings erected for the accommodation of the Railroad employees."

## Timber Resources

In the 1600s the eastern edge of the Pine Bush was only about 2 miles west of Fort Orange. Inhabitants of Fort Orange and the town around the fort, Beverwyck, harvested trees from the Pine Bush for fuel wood, building timbers, and stockades. Adriaen van der Donck (1968) found that hardwoods surpassed every other kind of fuel wood for its heat and duration of burn. Pitch pine was avoided by early colonists as fuel wood for cooking and heating because it produced large amounts of smoke, and the soot and tar that were produced increased the risk of chimney fires. The preferential removal of hardwoods may have promoted the expansion of pitch pine–scrub oak barrens communities, as it did in central Suffolk County (Kurczewski and Boyle 2000).

Gov. Thomas Dongan, in his 1686 charter establishing the City of Albany, granted the people of Albany the privilege of cutting wood in the Pine Bush. Use of Pine Bush timber increased during the military unrest of the late 1600s and the 1700s. The city imposed a requirement on its citizens, under penalty of fine, of providing firewood for city guards and large pitch pine posts for stockades. Large pitch pines became a scarce commodity as the eastern border of the Pine Bush moved westward with forest depletion. Because of the danger of attack, it was difficult to scout for timber deep in the Pine Bush. In 1717 the patroon granted permission to Albany to use the woods of the Manor of Rensselaerwyck, and several saw mills were located along streams (Huey 1975; Rittner 1976c).

Pine Bush timber continued to be an important resource throughout the 18th and 19th centuries, although forest resources were becoming depleted. Early in the 1800s, pine fuel wood

was taken from the city commons to feed the hungry Hudson River steamboats, which required seven cords of wood for each of 144 trips per season. The glass factory in Guilderland closed in 1815 for want of fuel. Saw mills were few at this time on account of the scarcity of timber (Howell and Tenney 1886; Rittner 1976c).

## Sand Resources

Presumably because of forest resources, an abundant supply of sand, and available water power, a glass factory was established in the Rensselaerwyck wilderness around 1785 on the Hunger Kill, a tributary of the Normans Kill. The potash used in glass making was produced locally. The principal output of the glass works was window glass, but snuff bottles, demijohns, and pocket bottles also were made (Gregg 1951). Indians were employed to weave covers on the demijohns. Strapped for cash, the venture closed in 1789. In May 1793 a new glass company was offering a reward for discovery of suitable sand within 10 miles (16 km) of the glass house (Gregg 1936; Huey 1975). In 1797, after several reorganizations, the glass works was incorporated as the Hamilton Manufacturing Company. The area known as Glass Factory, 10 miles west of Albany on the Old Schoharie Road, was renamed Hamilton in honor of the late secretary of the U.S. Treasury. After 1803 it would be known as Guilderland.

The glass works were described in the *American Gazetteer* (Morse 1797) as "one of the most decisive efforts of private enterprize [*sic*] in the manufacturing line, as yet exhibited in the United States. The glass manufactory is now so well established, and so happily situated for the supply of the northern and western parts of the State of New-York, as well as Vermont and Canada, that it is to be expected the proprietors will be amply rewarded for their great and expensive exertions. The glass is in good reputation. Here are two glass-houses, and various other buildings, curious hydraulic works to save manual labour, by the help of machinery. A copious stream runs through the heart of the settlement which lies high; and being surrounded by pine plains, the air is highly salubrious."

The factory increased its production during the 1790s, and according to Huey (1975) vast areas of pine forest were evidently cut for wood. In 1814 the Hamilton Glass Factory advertised in the *Albany Argus* (1814), promising liberal wages and constant employment through the fall and winter for a number of wood choppers. Although the factory was annually producing 500,000 feet (152,000 m) of window glass by 1813, it soon closed. Inability to compete with cheaper European glass after the War of 1812 and depletion of the fuel supply cut from the Pine Bush contributed to the collapse of the Hamilton glass works (Brinkman 1945; Gregg 1936, 1951; McKearin and McKearin 1948).

The glacial and postglacial sedimentary deposits of the Albany area have played important historical roles in the regional economy. Thick deposits of well-laminated Pleistocene clays deposited in Glacial Lake Albany have been the foundation of a great brick-making industry. Clay products made in Albany County in 1925 were valued at about $1.5 million (Cook 1930).

Albany molding sands, or simply "Albany sands," were at one time known all over the United States, and the New York State Museum published two accounts of these products (Newland 1916; Nevin 1925). Mining began perhaps in the 1860s and continued for many decades. By far the largest share of sand came from within a stretch of 20 miles north and south of a line drawn between Schenectady and Albany (Newland 1916). Production from 1908 to 1914 ranged from 300,000 to 500,000 tons per year, exhausting about 125 acres annually, or a square mile in 5 years. In 1923 Karner, Crescent, and West Albany were important centers of production (Nevin 1925). Molding sands, which occur just below the soil level, were mined by hand, and the soil and sod were usually replaced after removal of the desired product. As Cook (1930) noted, the "common sand that we see drifting about in the dunes to the west of the city" lacks the clay bond that makes the Albany molding sand so valuable for use in brass, aluminum and iron casting. By 1925 it seemed that the supply of quality molding sand had diminished considerably (Nevin 1925).

In more recent times, concrete manufacturers favored Pine Bush sands for its low acidity and even texture. By the time sand mining was prohibited in 1975, many dunes had been stripped away (Stewart and Ricci 1988).

## Water Resources

The Pine Bush has long been a source of quality water. In 1850 Patroon Creek was dammed to create Rensselaer Lake, which supplied water to residents of Albany until 1875 (Rittner 1976c). The Pine Bush aquifer is composed of widespread, thick, and permeable sands. Beds of impermeable lake silt and clay that underlie the aquifer control the water table, and localized lenses of clay within the aquifer cause perched water tables (Dineen 1982). The water stored in the sand layers requires very little treatment to make it usable, but precautions must be taken to avoid polluting the aquifer. Today deep wells in the sand aquifer supply water to some of the neighboring municipalities. Removal of water from the aquifer lowers the water table and endangers Pine Bush wetland habitats.

## Residential, Commercial, and Industrial Development

At Center Station, often called Center, a railroad depot was built shortly after 1831 along the tracks of the Mohawk-Hudson Railroad. A few nearby houses accommodated railroad employees. By the mid 1800s, Albany's Pine Bush lands had been divided into 72 large lots that were then auctioned (Zantopp 2000). The area was the focus of an early land development swindle that was exposed in 1859 (Rittner 1976c). After 1880 Center was renamed Karner, for George Karner, a land speculator who would fail in his attempt to develop the area (Rittner 1979b). The land was sold and resold for ever larger sums of money. By the 1960s three development corporations owned the majority of the dwindling prime Pine Bush habitat. Residential development was still sparse, but mid 20th-century fire suppression policies and new transportation routes made the Pine Bush safer and more accessible for development. The New York State Thruway, which parallels the course of King's Highway through the Pine Bush for a little over a mile, was built in the early 1950s. The Adirondack Northway, Route 155, and Washington Avenue Extension soon dissected the area even more.

In 1953 Albany Mayor Erastus Corning revealed plans to open 3,000 acres of land on the city's western frontier in the Pine Bush to development. It became evident that the Pine Bush had promising development possibilities, and a few individuals took advantage of low land prices (as low as $138 per acre) to purchase large tracts for future development (Zantopp 2000). By the early 1970s, the infrastructure for residential development, including water lines, sewers, and the Albany Landfill (completed in August 1969), was in place. The Pine Bush became an area of intensified interest as Capital District urban development spread toward it. Albany, hemmed in by the Hudson River to the east and by other communities to the north and south, began to push westward into the Pine Bush. Houses, office buildings, warehouses, shopping malls, a city landfill, a university campus, a state office building campus, and parking lots conquered large areas of the fossil dunes where rare and unusual communities of plants and animals had reigned for thousands of years. Environmentally conscious individuals soon banded together in the interest of preserving remaining remnants of the once-extensive Pine Bush. However, development of the Pine Bush has significantly increased the Albany, Guilderland, and Colonie tax bases, so realization of a regional plan to create or increase a nontaxed nature preserve has been resisted by local communities, each of which maintains separate planning and development activities. As late as the 1980s, a quarter of the commercial development within Albany city limits occurred in the Pine Bush. The area of developed land in the Pine Bush increased from 174 acres in 1940 to 1,888 acres in 1990, resulting in a nearly 40 percent loss of natural vegetation (Finton 1998).

Krista Zantopp (2000) has written a revealing study and analysis of land use and protection in the Albany Pine Bush for the past half century.

# Conservation

Because of its unique ecology, unusual plant life, superabundant insect life, and accessibility to scientists and others interested in nature study, the Pine Bush has a long history and worldwide reputation as a collecting ground for natural history specimens. Early 19th- century accounts of Pine Bush natural history were published in local papers. Later in the century, the

schedule of trains stopping at Center (Karner) enabled collectors and picnickers to spend the first half of the day in the Pine Bush. This unique and diverse area earned a wide reputation among people interested in nature and outdoor recreation.

As early as 1914, the Pine Bush was mentioned as an area worth preserving by Arnold W. Brunner and Charles D. Lay, architects engaged by Albany Mayor James B. McEwan to prepare studies for the improvement of the city. They mapped the city waterworks property in the vicinity of Rensselaer Lake and proposed additions of areas to the north and west, creating a natural park of more than 1,000 acres (405 ha). "It is a region full of subtle beauties because of its softly modeled little hills, its tangle of shrubbery and its patches of pine and hardwood trees. From the tops of the ridges the rugged Helderbergs are seen outlined against the horizon, and at the south, the foot hills of the Catskills. The character of the area is wild and unspoiled and almost nothing is necessary except to provide and maintain a few paths and roads. In fact the less done to it the better" (Brunner and Lay 1914).

Beginning around 1940, Schenectady City Historian William B. Efner explored, studied, and publicized the Pine Bush for several years. He was especially interested in the historic and cultural remains of colonial life along the old King's Highway. Thus began earnest attempts to preserve the Pine Bush (Rittner 1976b). Up to this time, the Pine Bush had remained for the most part undeveloped. However, Albany's western frontier, radiating into the Pine Bush like a spoke from its Hudson River hub, soon became the focus of much attention as politicians and businessmen hatched plans for a new city within a city, located in the Pine Bush. Millions of dollars in federal, state, local, and private funds were spent building infrastructure. At the same time, many newspaper articles about this unique area appeared.

Fires had been a common occurrence in the Pine Bush. The area was used extensively for recreation, with bridle paths traversing it in many places. Evidences of past picnic sites were everywhere, and wholesale dumping of trash and refuse had marred the ravines. Almost yearly, fire sprang from carelessly tended picnic fires and unattended dumps, and vast areas burned (Treacy 1953). Folks less enthralled with nature continued to view the Pine Bush as a wasteland and a convenient and informal dumping ground. Rubbish was scattered throughout the area, and in the 1950s and 1960s, junk cars and derelict appliances dotted the landscape. With property development now raging, fire suppression became a priority in the Pine Bush. Natural fires on which the natural plant and animal communities of the Pine Bush depended were extinguished along with accidental fires carelessly lit by humans.

Individuals, citizens' groups, and governmental agencies attempted to plan balanced land use, weighing the need for economic development against the need to preserve the physical, biological, and historical value of the Pine Bush. During the late 1960s, renewed interest in preserving the area developed due to efforts of representatives from the Eastern New York Chapter of The Nature Conservaney, students from the Protect Your Environment Club at the University at Albany, and other local organizations. Soon People for the Pine Bush, representing several area groups, including those just mentioned and the League of Women Voters, Citizens to Protect the Environment, and the Environmental Forum of Albany State University, was leading conservation efforts and combating potential developments in the Pine Bush (Rittner 1976b). This coalition became frustrated with the lack of region-wide planning by local municipalities. It proposed that the Pine Bush should be recognized as a single unit geologically, botanieally, and in other respects, rather than as a series of areas within the municipalities. Furthermore, the group threatened litigation, conducted letter-writing campaigns, and enlisted other tactics to plead against piecemeal development of the Pine Bush (Zantopp 2000).

The Eastern New York Chapter of The Nature Conservancy was one of the first organizations

to realize the ecological value of the Pine Bush. In the 1960s and 1970s it tried unsuccessfully to work with landowners to buy parcels for preservation. The Conservancy is nonpartisan and does not lobby to change laws or public opinion. Its early efforts to preserve the Pine Bush were unsuccessful because of conflicts with long-range municipal development plans. It was instrumental in the formation of People for the Pine Bush as the political activist group that lobbied strongly to protect the Pine Bush. In 1971, following a meeting sponsored by the Eastern New York Chapter, the Research Subcommittee for Preservation of the Albany Pine Bush was formed to explore the possibility of acquiring several hundred acres of Pine Bush land. The Committee's report, titled *Operation Pinebush*, outlined a plan to acquire five areas considered especially appropriate for preservation and bufferable from nearby conflicting development (Jiusto et al. 1971). These were areas where pitch pine forest was well developed and controlled burning could be practiced. Up to that time, numerous proposals to set aside land in the Pine Bush had been made, but no land had yet been preserved. The authors of the report noted, "There is no more time for another unsuccessful attempt . . . Action must be taken now or ever-accelerating development will completely swallow this unique landscape and its natural resources." Environmental uniqueness, unspoiled nature, and public education significance were cited as reasons for conservation.

In 1972 Don Rittner, then an undergraduate at the University at Albany, helped launch a crusade to save the Pine Bush. Rittner founded and directed the Pine Bush Historic Preservation Project, Inc., a cooperative project of the City of Albany and the Environmental Studies Department at the State University of New York at Albany. Using his powers of persuasion and connections with Albany City Hall, he was instrumental in advancing the movement to save the Pine Bush. Mayor Corning provided resources for the excavation of historic tavern sites in the Pine Bush. The organization soon expanded its fields of interest to include natural history, geology, and land use, and it grew into a local environmental organization. Rittner compiled and edited a book on the Pine Bush titled *Pine Bush: Albany's Last Frontier*, which was published by the Pine Bush Historic Preservation Project in 1976. The book contains 20 articles on origins, topography, soils, climate, natural history, and historical and modern activities in the Pine Bush. It provided the foundation and a major stimulus for efforts to protect and preserve this unique natural area. The Project and its successor, the American Pine Barrens Society, Inc., also published three issues of *Skenectada* (1979, 1982 [cover dated 1980], 1986), a scientific journal dedicated to the study of American pine barrens, primarily the Albany Pine Bush. Through these vehicles, Rittner's untiring zeal has profoundly improved respect for the Pine Bush and pine barrens in general as natural resources worthy of public stewardship.

ALBANY
PINE
BUSH
PRESERVE
Please Help Protect This Unique Area
NO DUMPING, UNAUTHORIZED MOTOR VEHICLES
OR UNAUTHORIZED FIRES
This property owned and dedicated by a member of the
Albany Pine Bush Preserve Commission
Central Avenue, Albany, NY 12205 (518) 464-6496

In the foreword to Rittner's book, Albany Mayor Erastus Corning II (1976) recognized the recent tremendous upsurge in interest in preserving the Pine Bush and the need to find "the best balance between land owner and nature lover." Referring to infrastructure improvements that had been made in the Pine Bush under his administration, he wrote, "We cannot roll up the roads, nor can we dig up the sewers and water lines. They are going to be used; there is no way I know of that we can go back."

In 1973 Cornell University botanist and lepidopterist Robert Dirig launched a privately run scientific and political campaign, with Cornell entomology undergraduate John F. Cryan, to study and preserve the Karner blue butterfly and its sandy pine barrens habitats in the upper Hudson River Valley (Dirig 1994). The project was supported in principle by the Albany Regional Entomology Club and the Xerces Society, dedicated to insect conservation (Cane 1973). Dirig (1973) published an opinion that the Karner blue butterfly might soon become extinct at Karner. The Nature Conservancy had assessed the

region and recommended a 100-acre (40 ha) tract for preservation. Dirig and Cryan (1975) produced a booklet on endangered Pine Bush Lepidoptera, which was intended as a resource for those interested in land use planning in the Pine Bush. They proposed a Pine Bush preserve, to be purchased by the City of Albany, the Town of Guilderland, the Town of Colonie, and the State of New York acting together. "This is the last chance for the local governments involved to get together and acquire the last section of the pitch pine–scrub oak community that is large enough to survive as an entity." Dirig and Cryan were thus instrumental in piquing the public's interest in the Karner blue's decline and the preservation of its Pine Bush haunts.

Protection of Pine Bush land began in the early 1970s. In 1973 the New York State Department of Environmental Conservation purchased 472 acres (191 ha) for a little less than $1.3 million in funds generated by the Environmental Quality Bond Act of 1972. That tract became known as the Pine Bush Unique Area. Additional land acquisition and protection by the City of Albany, the New York State Office of Parks, Recreation and Historic Preservation, the Towns of Colonie and Guilderland, the New York State Department of Environmental Conservation, and The Nature Conservancy followed. Over the past 30 years, some $25 million has been spent to create the 2,750 acre (1,113 ha) Preserve (Zantopp 2000).

With conservation and development forces both in full swing, the New York State Museum published a study of the geology and land uses of the Pine Bush (Dineen 1975). "Plans to develop the Pine Bush that take into account the biota and geologic features of the land will not only enhance the beauty of the region and provide a sense of continuity with the past, but will also yield valuable dividends for the future. Preserve areas provide a means of storing water throughout the year, reducing the extremes of seasonal flooding and drought. They can also help avoid erosion of valley walls and siltation of streams."

In 1976 the Pine Bush Historic Preservation Project asked the State of New York to list the Karner blue butterfly as endangered. While reporting on battles over development in the Pine Bush, media attention now made the Karner blue the focal point of conservation efforts. The following year, it became the first insect to receive protection under the state's endangered species law. However, recognition on the endangered species list only meant that butterflies could not be taken or harassed. The law did not prevent habitat destruction (Rittner 1979c).

In 1978 Save the Pine Bush organized as a grassroots, all-volunteer, community group dedicated to saving this precious habitat. The organization has a zero tolerance policy toward development in the Pine Bush, and its primary tool is litigation. Outraged by Albany's approvals of Pine Bush development projects, the organization began a long and continuing program of lawsuits based on environmental laws. It is currently working to ensure the purchase of buffer and connecting properties in the vicinity of Preserve parcels. Save the Pine Bush, supported by a membership of hundreds of individuals, has a legacy of lawsuit after lawsuit. It often uses State Environmental Quality Review Act guidelines as the legal basis for its lawsuits, and it even invokes the endangered species status of the Karner blue butterfly to fight continuing development forces in the dwindling Pine Bush habitat. Inadequacies in environmental impact statements from developers are frequently targets for this watchdog organization. In the early 1980s, Save the Pine Bush sued the City of Albany for approving a Pine Bush rezoning request on the grounds that the city failed to require an environmental impact statement. The state Supreme Court agreed with the environmentalists and furthermore ruled that the city had improperly failed to consider the joint effects of all pending development projects on the Pine Bush. Mayor Thomas Whalen subsequently issued a moratorium on further Pine Bush development until an environmental impact study was completed in 1986. That study identified parcels with high preservation value, but it failed to consider the minimum acreage necessary to maintain the Pine Bush ecosystem and sustain the Karner blue butterfly (Zantopp 2000).

In 1980 a study of the Pine Bush area was completed for the City of Albany, the Towns of Colonie and Guilderland, and the Village of Colonie. This intermunicipal study found that more than 2,600 acres (1,052 ha) of Pine Bush should be preserved, that future economic development should reflect the needs of both people and nature, and that a coordinated system of planning and management was needed (Bristol, Litynski, Wojcik, P.C. 1980). In 1984 the New York State Natural Heritage Program prepared an Albany Pine Bush preserve design in response to requests from the Eastern New York Chapter and the New York Field Office of The Nature Conservancy.

During the mid 1980s, a series of development proposals led to the preparation of several environmental impact statements and associated studies. A finding of one of these studies, released in 1988, was that a total of about 2,000 acres (809 ha) must be protected and managed to assure the long-term survival of the Pine Bush and the endangered Karner blue butterfly (Givnish et al. 1988). Protection of this minimum area became a condition of permit approval for expansion of the Albany Landfill. In recent years, the City of Albany has generally required that developers set aside significant portions of undeveloped Pine Bush sites in exchange for development approval on the remainder of the site.

In 1988 the state legislature recognized the Albany Pine Bush as a landscape worthy of protection and management for ecological, recreational, and educational purposes. Article 46 of Environmental Conservation Law, passed December 29, 1988, required establishment of an Albany Pine Bush Preserve consisting of dedicated public land and voluntarily dedicated private land. It also established a commission of state and local government representatives and private citizens to manage the Preserve. According to Article 46, as amended in 1996, the Albany Pine Bush Preserve Commission consists of 11 voting members, including 4 citizens appointed by the governor, plus representatives of the Towns of Guilderland and Colonie, the City of Albany, Albany County, the New York State Department of Environmental Conservation, the New York State Office of Parks, Recreation and Historic Preservation, and The Nature Conservancy.

In May 1993 the Commission adopted a Management Plan (Environmental Design and Research, P.C. 1993), which evaluated the natural, recreational, and cultural resources of the Pine Bush and established goals for their protection and management. The plan also established goals of promotion of recreation and sponsorship of education initiatives. It was amended in 1996 with detailed recommendations for natural resource protection (Albany Pine Bush Preserve Commission Technical Committee 1996). Management Plan recommendations fall into four major categories. Natural resources are to be protected by protecting the land on which they occur through the formation of the Albany Pine Bush Preserve. Natural resources are to be managed by managing the ecological communities in which they occur with an aggressive program of prescribed burns and other ecological management techniques and with programs aimed at protecting and enhancing populations of native rare species and their habitats. The ultimate goal is to have 2,000 acres (809 ha) under active fire management. Public use of the Preserve is to be managed in a way that protects natural resources, primarily through development of appropriate access points, a trail system, and regulations regarding trash dumping, trespassing, use of off-road vehicles and other activities that destroy the Preserve's natural resources. Finally, public understanding of the significance of the unique natural area is to be enhanced by providing interpretive materials and educational programs.

The Commission now manages more than 2,750 acres (1,114 ha), putting it well over halfway to its goal of protecting nearly 4,000 acres (1,620 ha), including both fire-managed sites and buffer zones. At that size, scientists feel that native species can survive here.

## Protection and Management

Many forces at work in modern society have seriously challenged the ecological relationships and processes that created the unique plant and animal communities of the Albany Pine Bush thousands of years ago. Managers charged with protecting, restoring, and maintaining the natural communities of the Pine Bush must confront these challenges with a thorough understanding of plant and animal ecology and a talent for coordinating their efforts with other public and private interests in the Pine Bush. The following review looks at some of the major ecological management problems and possible solutions to them.

### Habitat Loss, Fragmentation, and Protection

One of the biggest threats to the Pine Bush ecosystem and its natural flora and fauna is continuing economic pressure to develop the area for housing, commerce, and industry. Because the Pine Bush is the last open space located between two major cities, Albany and Schenectady, and it is readily accessible with modern highways, it is ripe for development. The habitat that sup-

ports Pine Bush plants and animals is lost when Pine Bush sands are removed, covered with artificial structures, or altered in unnatural ways. Sand mining removes valuable habitat. Construction of buildings, landfills, and parking lots disturbs and covers the sands, alters the way water and nutrients circulate, and contributes unnatural chemicals to the ecosystem in leachates and runoff. Agricultural fields, lawns, and gardens disturb the soil, changing its nutrient and microorganism composition, and they replace native plant communities with artificial communities foreign to the ecosystem. Land that is developed for human use invites vehicular and foot traffic, which further disturb habitats and ecological processes necessary to the long-term survival of rare and unusual species and communities peculiar to the Pine Bush, especially those that live in exposed sand. Once native plants and animals are removed, it can be very difficult for these species to again occupy disturbed sites.

The long-lasting impact of human activity on the natural ecosystem is a critical component of conservation planning. Pine Bush lands that are developed for economic purposes present special management problems. The many rights-of-way that exist here are good examples. Niagara Mohawk, Conrail, the New York State Thruway Authority, and other public works organizations each has its own goals for the facilities it maintains on Pine Bush lands. Organizations might use vegetation management techniques that are not compatible with Pine Bush ecosystem functions. Unregulated human disturbances can easily extinguish the last population of a rare species.

As the Pine Bush has become smaller and smaller due to development, it has also become fragmented, with protected areas separated from one another by development and unprotected lands. Natural habitats have been divided into ever-smaller parcels, isolated from other similar parcels and less and less capable of maintaining natural ecological processes and the biological diversity typical of the Pine Bush for the last several thousand years. Small tracts are unsuitable for breeding populations of some birds, mammals, and other species. Fragmentation disrupts dispersal patterns of native species, reducing opportunities to move to new areas of habitat or use a variety of habitats. Isolated populations are threatened with local extirpation because of demographic, genetic, and catastrophic processes that work on small populations. The increased likelihood of inbreeding produces genetically depauperate populations. Fragmentation makes vegetation management with prescribed burns difficult. It also results in an increase in the amount of perimeter outlining the Pine Bush (Zantopp 2000). The pine barrens become more exposed along roads and developed lands. Peripheral areas of habitat fragments are exposed to an altered regime of environmental conditions, which is known as the edge effect (Gill 1997). Shrubs, herbaceous plants, and associated animal species that prefer the increased light at edge habitats, or ecotones, prosper at the expense of more typical Pine Bush species. With more perimeter, the interior of the Pine Bush becomes more vulnerable to invasion by non-pine-barrens species, including pest insects and plant diseases. Later successional communities encroach on the pitch pine–scrub oak community. With fragmentation, the barrens are also more easily exposed to pollution, including solid waste, air pollution, and oil and gas residues.

Protection of Pine Bush lands as an Albany Pine Bush Preserve is the first step in managing the area to restore and perpetuate its unique assemblage of ecological communities and rare species. The state, various municipalities, and The Nature Conservancy have dedicated protected Pine Bush lands that they own to the Preserve for management by the Commission. The Commission has the duty to recommend additions to the Preserve. The Albany Pine Bush Management Plan calls for acquisition and dedication of additional undeveloped lands harboring ecologically significant sites by purchase from willing sellers. However, acquisition of private lands is not feasible in every case, and acquisition of developed land is not recommended. Alternatives to acquisition that would provide for protection of ecological resources within the Preserve include set-asides associated with Pine Bush development projects, grants of conservation easements that provide the Commission with management authority, cooperative agreements, voluntary management by others (highway departments, utilities, private landowners, etc.), legal designation of lands as Critical Environmental Areas, and adoption by municipalities of zoning and land use regulations designed to reduce potential environmental impacts associated with development, such as soil erosion, stream sedimentation, noise and visual disturbance, and habitat loss.

Dedication of land to the Preserve is for management purposes only. It does not represent a

transfer of ownership. Dedication involves development of a legal agreement or passage of a legislative act that outlines the rights and responsibilities of the Commission and the landowner. The Commission is not a regulatory agency with permit jurisdiction over private property. It has no authority to acquire land by eminent domain. It can, however, accept gifts and grants of land from public and private sources. The Preserve is assembled from voluntary gifts or grants to the Commission and from lands purchased by public and private entities other than the Commission for subsequent incorporation into the Preserve. The Management Plan does not call for displacement of existing residents or businesses.

The protection goals are to assure dedication of a reasonable minimum acreage of restorable pitch pine–scrub oak community that can be managed through prescribed burning, acquisition of linkages to increase contiguity and provide animal and plant dispersal corridors among Preserve lands, protection of buffer zones between the Preserve and developed areas, and protection of isolated Karner blue butterfly colonies, streams, wetlands, geological features, and historic and archaeological sites. Research suggests that a minimum of 2,000 acres (809 ha) that can be aggressively managed is required for long-term conservation of the Albany Pine Bush ecosystem and the Karner blue butterfly. The vision outlined in the 1996 amendment to the Management Plan calls for 3,950 acres (1,599 ha) under full protection by purchase or conservation easement, of which 2,390 acres (967 ha) would be fire-manageable. In addition, approximately 570 acres (231 ha) exist that can be maintained as open space (to remain as park, country club, landfill, through conservation easement or management agreements) to further protect the Albany Pine Bush. Portions of another 1,920 acres (777 ha) are recommended for partial protection, of which 720 acres (291 ha) are fire-manageable pitch pine–scrub oak habitat.

## Wetland and Aquifer Degradation

Pine Bush wetlands represent a special case in habitat loss and destruction. They suffer direct loss from development projects, loss from artificial lowering of the water table, and degradation from pollution. Wetlands become dry when the aquifer is diminished and the water table is artificially lowered. This happens as water is removed from the aquifer through wells and when runoff cannot recharge the sandy aquifer because storm sewers, highways, and drainage projects divert it. Roads, parking lots, and buildings adjacent to streams concentrate storm water runoff and contribute silt, salt, petroleum products, and nutrients to the wetlands and the aquifer. Ground water in Pine Bush sands is readily contaminated by seepage from septic tanks and landfills, oil or chemical spills at construction and industrial sites, and winter deicing operations.

Pine Bush wetlands have been dramatically reduced in area. Comparisons of wetland areas shown on topographic maps from the early 1950s with areas shown on revised maps of the late 1970s demonstrate recent losses. Many swamps have been drained or filled. The last significant Pine Bush bog community, Poplar Street Bog, east of the intersection of state Routes 5 and 155, was destroyed in the 1970s. Judging by historic plant records, a fen community once occurred in the Pine Bush, but it cannot be seen today. Pine barrens vernal ponds were probably common in interdunal depressions in the 19th century, but they are relatively infrequent today. Vestiges of *Carex* hummocks in adjacent woods are indications of wetland shrinkage. Wetland plant communities are very sensitive to seemingly minor changes in the level of the water table. Artificial changes in hydrology and fire ecology alter the character of wetland flora and fauna by inducing unnatural succession (Mattox 1994). We have seen in previous discussions that recorded loss and imperilment of Pine Bush biodiversity have occurred mainly in the wetlands, especially among vascular plants, insects, amphibians, and reptiles.

It is important to protect the wetlands because they harbor several locally rare species, including the eastern spadefoot and other amphibians. Some imperiled Pine Bush plants, such as red-rooted flatsedge (*Cyperus erythrorhizos*), are associated with vernal ponds, which need protection from development, construction, and agricultural activity that may alter their ecology. Seasonal flooding and drying is a natural ecological process in vernal ponds, and many species depend on it for their survival. Although the historic role of fire in maintaining the open vegetation of the vernal pond community is unclear, it seems that with fire suppression, wetlands could be threatened by encroaching woody vegetation, (Mattox 1994; Schneider et al. 1991). Protecting Pine Bush wetlands requires the preservation of hydrologic, chemical, and fire processes.

Development pressure can impact wetlands by altering the natural hydrologic, chemical, and fire regimes.

Watershed protection is essential to assuring continuation of hydrologic processes essential to the survival of Pine Bush wetlands. A buffer zone around the Preserve would help to achieve this goal. Construction adjacent to the Preserve must be monitored and regulated to ensure that the watershed is protected (Albany Pine Bush Preserve Commission Technical Committee 1996; Environmental Design and Research, P.C. 1993).

## Fire Suppression and Vegetation Management

In the Pine Bush, the threat of habitat destruction through fire exclusion ranks in importance with habitat loss through development. Fire is a natural and necessary process in the Pine Bush ecosystem because it maintains the open communities needed for the survival of the rare and unusual species that occur here. It prevents vegetative succession leading to a closed forest canopy that occurs in surrounding, less flammable ecosystems. It does this in several ways. It destroys small plants of fire-intolerant species, thus eliminating these species from the community. It also destroys accumulated organic matter on the soil surface, thereby discouraging the establishment of species that require more fertile conditions. In the course of vegetative succession, these species would replace the Pine Bush plants that tolerate low-nutrient, fire-prone conditions. Fire stimulates germination and sprouting of fire-tolerant species, which can then grow free of competition from fire-intolerant species. The Albany Pine Bush is a mosaic of natural plant communities, all of which have probably experienced fire at regular intervals. Although there is some disagreement as to the exact fire-return interval, most agree that xeric sites, such as the pitch pine–scrub oak barrens, historically experienced fire every 6–15 years. Sites supporting more mesophytic species, such as ravine forests, are less fire-prone than sites on the sandy dunes. Although their fire regimes are not well known, historically they probably burned periodically under droughty conditions, but at longer fire-return intervals. Artificial changes in fire ecology have probably altered the character of wetland flora and fauna by inducing unnatural succession. During drought years, fires burn into wetlands, top-killing shrubs and trees and exposing wet sand, a possible habitat for some rare species. Fire suppression in pine barrens vernal ponds probably allows invasion of gray birch and quaking aspen.

Fire is not especially welcome in the vicinity of developed land. There is a high level of social pressure to artificially suppress fires in order to protect human life and property. The most intense fire suppression probably occurs on the periphery of the Pine Bush, adjacent to homes and businesses. Pine barrens vegetation occurs primarily in the center of the Pine Bush, where, until recent decades, fire posed the least threat to humans. Today, however, there are some areas that have not burned for 40–50 years or longer. In the absence of fire, succession resumes, and the canopy closes. Deep litter layers create seedbeds unsuitable for germination of pitch pine seeds, but favorable for invading species, including rapidly growing species that are difficult to eradicate, such as trembling aspen, sumacs, black locust, brambles, gray birch, pin and black cherries, common chokecherry, and tree oak species. With fire suppression, these species have out-competed and displaced native pine barrens species in many areas. Grass and heath openings have closed, and critical butterfly food plants, such as wild lupine and New Jersey tea, are shaded out. Pine Bush species can persist for some time, but under fire-free, disturbance-free conditions, they quickly lose their ability to reproduce and compete for resources. Artificial forces, such as foot and bike traffic and mechanical and chemical vegetation management along rights-of-way, can produce a disclimax state similar to that maintained by fire, allowing Pine Bush species to maintain for a time, but these disturbances often are not long-lived and they can produce undesirable side-effects as well. It is apparent that in the absence of periodic fire, the pine barrens ecosystem of the Albany Pine Bush would disappear.

Given that wildfires can no longer be allowed to maintain the natural condition of the Pine Bush, it is clear that Pine Bush communities can be restored and maintained only through some form of active vegetation management. The cornerstone of the management program is controlled, prescribed fire targeted toward restoration and maintenance of pitch pine–scrub oak barrens and other native communities. Under this program, fires deliberately set and controlled are used to manipulate habitat structure to favor certain plant species, to improve habitat for ani-

mals, to control invasion by undesirable plants, and to reduce the hazard of unmanaged wildfire associated with accumulation of large amounts of dry plant litter.

Fires can be prescribed at different frequencies, intensities, seasons, and extents. There probably is no optimum fire regime for maximizing biological diversity in the Pine Bush. A fixed regime could impoverish biodiversity by repeatedly favoring the same species at the expense of others. For example, dormant-season fire favors certain grasses while destroying other native species. Fire could easily destroy the immobile eggs of rare butterflies and moths if host vegetation is burned during the wrong season. A fire regime varied over time and space can be used to create diverse conditions that will not encourage dominance of a single species. Managers should strive for spatial and temporal heterogeneity when planning prescribed burns. Increased complexity in the postburn environment will lead to increased probability that all components of the ecosystem will survive. Unburned patches of vegetation and litter should be conserved as shelters or refugia from which species can recolonize burned areas.

There are many problems associated with the use of prescribed fire as an ecological management tool in the Pine Bush. We have an incomplete understanding of the consequences of prescribed fire. Little is known about its effects on most Pine Bush species. Will it inadvertently favor one species at the expense of another desirable species? Will it harm or eliminate a rare or unusual species? Fundamental knowledge of the effects of fire management on insects lags far behind that available for other groups of organisms. How long does it take for populations of each species to recover from prescribed fire? Research is needed on how different fire regimes promote or reduce particular species, how to achieve desired fire characteristics under different weather conditions, and how communities recover following fire. Ecological management with prescribed fire must be approached as an experimental technique requiring constant and extensive monitoring, collaboration between managers and researchers, and dissemination of research results.

Historically the Pine Bush probably burned during hot, dry conditions or drought, and, undoubtedly, fires were occasionally intense. Because of safety concerns and public opinion, prescribed burns are likely to be small-scale, low-intensity fires scheduled for moist spring or fall weather. This unnatural, prescribed fire regime could produce ecological problems because the biota evolved under a different set of fire conditions. Eggs of Karner blue butterflies and buck

moths are vulnerable at these times. Deeply buried seeds of legumes may not be stimulated to germinate if low-intensity fires do not heat the soil sufficiently. If prescribed fire is used too frequently, populations of plants that do not resprout could be at risk if a second fire destroys seedlings germinating in response to a previous fire. Frequent prescribed fire could encourage encroachment of weedy species and unusually rapid accumulation of fuel.

Restoration of the pitch pine–scrub oak community is the main objective of the prescribed fire program in the Albany Pine Bush. Areas supporting successional southern hardwood forest, pine plantation, or brushy or open cleared land are considered restorable. These plant community types have expanded or invaded as a result of either physical disturbance or fire suppression. Successional northern hardwood forest, Appalachian oak–pine forests and pine–northern hardwood forest historically occurred in the Pine Bush, but they have expanded in response to fire suppression. They are targeted for only limited restoration to pitch pine–scrub oak. Aside from pitch pine–scrub oak, other natural, desirable community types, including pitch pine–oak forest and pine barrens vernal ponds, could also benefit from prescribed burns.

There are at least two approaches to prescription burning in the Albany Pine Bush Preserve. The prevailing opinion calls for duplication of the historic fire regime. Unfortunately our knowledge of the historic regime is meager. In the pitch pine–scrub oak community, fires every 6–15 years probably burned areas up to 1,200 acres (486 ha), with the average fire burning perhaps 100 acres (40 ha). Fires were occasionally intense. Because of safety and public opinion concerns, intense fires are unlikely to be prescribed. Experience from controlled burns suggests that burn units larger than 50 acres (20 ha) are unwise due to intense development near the Preserve and smoke management issues (Gebauer 1996; Zaremba et al. 1991).

The other approach discounts prescribed fire as a management tool because so little is known about its effects on most pine barrens species. The Albany Pine Bush is a set of remnant communities. There are few nearby populations of characteristic Pine Bush plants and animals that could serve as a source for recolonization by immigration. It could be argued that it is therefore wise to keep burn management to the minimum required to maintain native vegetation. Representative refuges should always be maintained within the Pine Bush to facilitate recolonization. Proponents of this approach maintain that the periodic random fires that do start, primarily in dry months, should be allowed to burn themselves out (Dirig and Cryan 1975).

The existing prescription assumes a management scenario in which an average of 200 acres (81 ha) of pitch pine–scrub oak barrens are burned each year on a 10-year cycle. A minimum of 2,000 acres (809 ha) of restorable and manageable pitch pine–scrub oak is therefore required for the Preserve. Given the fragmented nature of the Preserve and the proximity of development, numerous small burns will be required. The challenge to managers is one of how to duplicate the natural effects of the historic Pine Bush fire regime within the constraints of the modern Pine Bush configuration and social, political, and economic environment (Albany Pine Bush Preserve Commission Technical Committee 1996; Environmental Design and Research, P.C. 1993; Givnish et al. 1988).

Although prescribed fire is the preferred vegetation management tool, it may not be effective or practical in every situation. Fire in buffer zones of the Preserve could adversely impact adjacent properties or residents. Under wet and cold conditions, the state of the vegetation does not permit fire. In severely degraded communities, where fire has been suppressed for a long time, invading species may have grown beyond the fire-susceptible stages. Under these conditions, it may be necessary to use alternative mechanical or chemical management tools as a supplement to prescribed fire. However, it is unlikely that these techniques could effectively maintain pine barrens communities in the long term. They do not provide conditions that give pine barrens species a competitive advantage, such as exposed mineral soil seedbeds, seed scarification, or sudden soil nutrient flushes. Accumulation of organic refuse from girdling, clear cutting, brush hogging, and mowing increases the hazard of wildfires. The breakdown of this material changes the nutrient dynamics of the ecosystem, leading eventually to changes in plant community composition and structure.

In the following two articles, Christopher Hawver and Joel Hecht discuss the managers' perspective on vegetation management in the Albany Pine Bush using prescribed fire and mechanical and chemical techniques.

## The Role of Fire in the Albany Pine Bush

*by Christopher A. Hawver, Albany Pine Bush Preserve Director of Research and Management*

### *Introduction*

The sand dunes of the Albany Pine Bush support a globally rare natural community known as pitch pine–scrub oak barrens. This unique assemblage of plants and animals is considered the best example of an inland pine barrens remaining in the northeastern United States. Similar to the coastal pine barrens of Cape Cod, New Jersey, and Long Island, the Pine Bush is a fire-maintained ecosystem composed of an open, pitch pine canopy overlooking a dense, shrub canopy of scrub oaks. Grassy openings of low sedges and tall prairie grasses meander through the scrub oaks. Blueberries, dwarf willows, and cherries grow among thriving wildflowers in the sunny openings. Wild blue lupine, the sole food plant of the Karner blue butterfly larvae, is imperative to the survival of this endangered insect and requires this open and

### *Fire Dependence*

The creation and maintenance of the Pine Bush and other northeastern pine barrens have been attributed to natural and human-induced fires. Investigations of fire history indicate the Pine Bush likely experienced periodic burning for thousands of years, as often as every 10 to 20 years. Natural fires are thought to have begun from lightning strikes in dry vegetation during droughty periods. Human activity in the Pine Bush dates back to more than 10,000 years, and fire is believed to have been used by Native Americans and later by colonial settlers for a variety of purposes. Historically humans used fire as a tool to: (1) manage game by improving habitat and drive animals during hunts; (2) increase berries and other food crops; (3) fight wars or defend homes; and (4) prepare land for farming or improve grazing conditions for livestock.

### *Fire Effects and Plant Adaptations*

Fires limit tree and shrub growth and modify the plant community. Without fire, faster and taller growing species such as hardwood trees and white pines would outcompete and displace pine barrens species. Most of the plants native to the Pine Bush have developed adaptations to help them survive, or even require periodic fire events for their maintenance or reproduction, and therefore flourish following fire. Pitch pine has a thick bark that insulates the tree from the heat of a fire. Even if the entire needle canopy of the pine is consumed in a fire, the tree often survives from hidden, epicormic buds that resprout along the trunk and branches. Some pitch pines have closed, serotinous cones, sealed shut with a waxy resin. This resinous bond is broken during a fire, when the heat melts the resin and allows the cone to open and disperse its seeds. Even if the cones open without fire, the seeds germinate only on exposed mineral soil (sand), a condition created by periodic burns. Scrub oak and other shrubs have the ability to resprout from a root crown, which is insulated by the soil from heat. The aboveground portions of such species are top-killed in a fire, but the plants grow back from vigorous resprouting. Other plants have adapted to fire by producing great quantities of seeds or generating seed at an early age. Still others, such as New Jersey tea, depend on fire to crack or scarify its hard seed coat, which then allows the seed to germinate.

Fire removes standing dead plant material and increases solar radiation reaching the soil. Because of the increased solar radiation, soil temperatures on burned areas are higher than in unburned areas. Increased soil temperatures promote earlier root growth and activity, and thus earlier emergence of plant shoots. However, if an area is burned too early in the season, lower production may result due to increased loss of soil moisture

*continued*

## The Role of Fire in the Albany Pine Bush, *continued*

from the bare ground before resumption of spring growth. If an area is burned too late, plants that have already started to grow will be set back. The stored carbohydrates that they spent on spring growth will be diminished, and recovery time will be longer.

Fire temporarily increases available nutrients in the soil, which may lead to improved flower and seed production in some species. Fire also produces the alkaline soil conditions needed for germination of bracken spores.

### *Fire Exclusion*

In the early 20th century, it became policy to suppress all fires within the Pine Bush. The 1940s brought the development of motorized fire-fighting equipment, which resulted in quicker response times to fires. Combined with misconceptions that fire was detrimental to plant and animal communities, the ecological force that formed and maintained the Pine Bush was ultimately excluded. Fire exclusion has negatively impacted the fire-dependent species that inhabit the Pine Bush. In the absence of fire, the pitch pine canopy begins to close and grassy openings are crowded out due to increased density of the oak understory. In areas where fire has not occurred for many years, deep litter layers create seedbeds unsuitable for many native plants to germinate. However, such conditions are favorable for invading species. In many cases native species such as the blue lupine are nudged out by weedy species such as locust and aspen that quickly invade and may even become the dominant species. With an increase in the density of the vegetation, the amount of flammable material also increases, creating hazardous fire conditions. Such conditions may lead to wildfires that are difficult to contain. One such fire occurred in the early 1980s that burned several hundred acres, damaged nearby powerlines and sent great amounts of uncontrolled smoke toward sensitive areas.

### *Returning Fire to the Albany Pine Bush*

Recognizing the important role that fire plays in maintaining the Pine Bush, the New York State Legislature in 1988 created the Albany Pine Bush Preserve to protect the remaining acres of pine barrens, and the Albany Pine Bush Preserve Commission, the oversight body charged with the complicated task of coordinating the management of these lands. A section of this legislation specifically called for the use of controlled burns to manage the Pine Bush. Prior to this special law, burning in woodlands for any purpose was prohibited since the early part of the century. Under a contract with the Commission, scientists with The Nature Conservancy prepared a fire management plan in 1990 (Zaremba et al. 1991) as a result of extensive research in both fire ecology and the unique physical and geographical attributes of the Pine Bush. The plan called for several prescribed burns to take place beginning in the spring of 1991. The first burns were small (1- to 3-acre) research burns that have provided information useful for predicting fire behavior in the Albany Pine Bush on a larger scale.

### *Fire Management in an Urban Preserve*

There are many challenges to prescribed burning in the Pine Bush due to the urban infrastructure that divides it into disjunct sections. Smoke is a major concern and is strictly managed. Commercial and residential development, nursing homes, a regional airport, and major highways border protected lands, and the New York State Thruway runs through the Preserve's center. Precise environmental and weather conditions that allow smoke to rise high into the atmosphere and disperse away from sensitive areas are required for all controlled burns. Using specially trained management crews and conducting detailed planning well in advance allows for such burns to occur despite numerous challenges. Due to the population that surrounds the Pine Bush, an extensive education and notification program keeps the public well informed of any plans for controlled burns.

*continued*

## The Role of Fire in the Albany Pine Bush, *continued*

### *Program Summary*

Since the beginning of the program, a better understanding has been developed regarding how fire and smoke behaves in the varying natural community conditions. Larger fires, simulating more natural conditions, are being conducted so that fire can be reestablished as the primary ecological process that restores and maintains this unique ecosystem. Due to the need to control and manage smoke, fires larger than 25 or 30 acres are difficult to conduct. However, repeated burns result in conditions that historically were created from naturally occurring fires. Experimental burns are conducted during different times of the year and under different conditions, providing data on how to best manage the rare inland pine barrens of the Albany Pine Bush. Fire management activities and results are monitored continually.

## Alternative Management Techniques

*by Joel Hecht, Albany Pine Bush Stewardship Director*

Management of the Albany Pine Bush Preserve involves numerous techniques and methods. As previously explained, there are a number of reasons why the Preserve needs to be actively and sometimes intensely managed. Beyond the complex and intensive fire management program, a number of other techniques are being used to manage this unique ecosystem. The following is a brief discussion of these techniques, their purpose, and the intended goals.

### *Aspen Girdling*

Aspen trees, though native to the Pine Bush, have become a problem in many areas of the Preserve. These trees are invasive and fast growing, and they are out-competing desir-

*continued*

## Alternative Management Techniques, *continued*

able Pine Bush vegetation. Historically fire maintained the balance between these and the fire-adapted species that dominated most of the Pine Bush. Because natural fires have been suppressed for many years, aspen trees have spread rapidly. The dense shade they create eliminates most of the more typical Pine Bush vegetation that thrives in full or partial sun.

Reducing the number of these trees is not an easy task. If the trees are burned or cut down, they simply resprout from the roots. A technique referred to as girdling is effective because it allows nutrients and water to be transported to the leaves but does not allow transfer of the sugars to the roots in the fall. Girdling exhausts the energy stored in the roots, effectively reducing potential resprouting and therefore reducing the number of aspen trees found in the Preserve.

Aspen girdling is most easily accomplished during the months of May, June, and July on trees that are at least 3 inches in diameter at waist height. The trees are girdled using a tool called a bark spud. A sharpened metal edge on the end of a wooden handle is inserted under the bark and used to peel off a portion of the bark completely surrounding the trunk of the tree near the base. The tree will be exhausted and die in 2 or 3 years, allowing the forest canopy to open. As sunlight again reaches the ground, native Pine Barrens vegetation will be able to reclaim the area. Scrub oak, blueberry, huckleberry, and grasses such as little bluestem and Indian grass will once again flourish. Wildflowers and shrubs will also grow and once again dominate these newly opened areas.

Because the wood of the aspen tree is soft, the trees will fall after 3–5 years and will rot quite rapidly. Regular controlled burning by the Commission will prevent aspen trees from dominating these areas again, while maintaining desirable Pine Barrens vegetation.

Volunteers and students from local schools have girdled thousands of trees in the Preserve over the past 4 years. It is expected that this management technique will be used as a primary restoration technique over the next 3–5 years. Ongoing efforts will probably continue for the next 10–15 years as young stands of aspen trees become large enough to girdle.

To date there has been little if any resprouting associated with the girdling of these trees. In addition to the root resprouts, the trees also produce seeds that sometimes grow once the forest canopy is opened. Fire will be the primary management technique used to control seedlings, preventing the aspen from regaining a dominant foothold in the Preserve.

### *Mechanical Management*

Another method being used to manage the Preserve is mechanical vegetation control. Mowing the vegetation is a necessary and effective way to meet a number of the Commission's objectives.

For several years the Commission, in cooperation with the U.S. Fish and Wildlife Service, has used a machine called a hydro-axe to mow thick vegetation in several areas of the Preserve. The machine is hydraulically operated and uses a blade 8 feet long to cut and shred shrubs and trees with stems up to 6 inches in diameter. This method has proven effective at reducing the stature of the scrub oak in areas where prescribed fire would be unmanageable due to the quantity, size, and flammability of the vegetation. By mowing the area and then allowing the vegetation to regrow for several seasons, the area can then be managed with fire on a rotating schedule that would not allow the vegetation to become large or unwieldy again. Although effective and necessary, fire in the urban area where the Pine Bush is found is not the only tool that can be used. Because fire has been suppressed in these areas for 50–75 years, mowing used prior to the first prescribed burn is an effective method that allows the Commission to continue management in a controlled and ecologically effective manner for years to come.

Mechanical management will probably be used on a limited basis for a number of years until a complete rotation of burning has occurred on these lands. As additional lands are added to the Preserve, these also may require initial mechanical treatment.

*continued*

**ALTERNATIVE MANAGEMENT TECHNIQUES,** *continued*

### *Chemical Management*

Weeds are a major threat to the viability of natural communities, both inside and outside of the Pine Bush. There are a number of weeds that are out-competing the native Pine Bush vegetation. These range from small flowers such as garlic mustard to tall trees such as black locust. There are various ways to deal with each, and some are more effective than others. Although chemical control is used as a last resort, it is, at least in the case of black locust, the only method known to help eradicate this pest.

Black locust is a major weed to both the Northeast and the Pine Bush. Imported from the Southeast because of its rot-resistant wood, rapid growth, and soil-stabilizing root system, it has quickly spread into almost every corner of the Pine Bush. It often keeps native plants from growing in its understory or only allows other undesirable weeds to grow under its canopy. Often these other weeds will also need to be eliminated as part of the restoration process. Black locust's clonal characteristics and ability to resprout vigorously have challenged nonchemical eradication methods. Cutting, burning, and girdling only stimulate the plant to grow and spread. However, research in the Preserve and in other areas of the country has shown that black locust will not resprout if stumps of cut trees are treated chemically. Herbicide is drawn into the root system and kills the tree completely. After locust is treated and removed, sites will be replanted with native Pine Bush vegetation. Younger stands of locust trees may still have enough desirable Pine Bush species in the understory so that increased sunlight following locust eradication may be enough to allow them to dominate once again. As with the reduction of aspen trees, it is expected that regular controlled fires will maintain these areas once they are restored and have stabilized with desirable Pine Bush vegetation.

### *Reclaiming Disturbed and Weedy Sites*

Although this area of management is in its formative stages in the Pine Bush, the Commission recently began an ambitious effort to restore vegetation in degraded areas in the Preserve. Because areas of the Preserve will eventually need to be replanted with native Pine Bush species, efforts are underway to find the best cultivation methods for native Pine Bush vegetation.

In the spring of 1998, a 4-acre parking lot purchased by the Commission was removed. The site was replanted with native plant species, especially those important to the Karner blue butterfly. These include wild blue lupine, butterfly-weed, horsemint, and New Jersey tea. The site was irrigated the first summer to help the plants become established. It is expected that the plants will spread on their own and dominate the area over the next 2–4 years. Nearby Karner blue butterfly populations are expected to move onto this site once the lupine plants become established. Research continues as to the best and most cost-effective ways to reclaim these areas of the Albany Pine Bush Preserve.

## Invasive and Nonnative Species

Competition from invasive native and nonnative species on disturbed sites is a serious threat to rare native species and to the integrity of the ecosystem. Native plant communities of the Albany Pine Bush contain many relatively slow growing plants, such as pitch pine and little bluestem, that specialize in low-nitrogen habitats. The spread of competitively superior native and exotic plant species has altered both upland communities and wetlands in the Albany Pine Bush. Fire suppression and other disturbances have allowed certain weedy, invasive species, such as black locust, quaking aspen, and spotted knapweed, to encroach upon the upland sites of these less aggressive native plants and nudge them out, along with all the insects and other animals that depend upon them. In the lowlands, under conditions of fire suppression and a lowered

water table, gray birch, quaking aspen, and meadow-sweet invade vernal pond communities and displace rare herbaceous species. Common reed and purple loosestrife invade shallow emergent marshes. Invading plant species can increase soil nitrogen levels, giving themselves a competitive advantage over native plants. Invasive species also reduce species diversity by monopolizing heterogeneous habitats that would otherwise support many native species. Invasion gradually excludes native species, leading to decreases in diversity and loss of characteristic, rare, and unusual species. Weedy species have even become the dominant species at some sites, and they present a major management challenge. Aggressive and nonnative invaders alter the landscape and the ecology of the Albany Pine Bush in sometimes subtle ways. The readily available foliage of invading black locusts supports caterpillars of the silver-spotted skipper, a common and conspicuous Pine Bush butterfly. Large populations of adult skippers, in turn, are commonly seen visiting flowers of introduced spotty knapweed and purple loosestrife. Although this scenario may seem beautiful, it is actually quite artificial and destructive to the Pine Bush ecosystem.

Certain animals also interact with the Pine Bush ecosystem in unnatural ways, altering its ecological relationships. Introduced predators such as cats may cause declines in populations of small vertebrates. The number of white-tailed deer expanded substantially in the 1970s, and it continues to be out of balance with its food supply and with human occupation of the land. Deer damage native vegetation, gardens, agricultural crops, and ornamental shrubs. It is believed that one of the many reasons for the decline of the wild lupine in the Pine Bush is deer grazing. In her wetlands survey, Janet Mattox (1994) recorded as her "saddest deer episode" an incident in which three small purple fringed orchids in full bloom were consumed by deer. It is easy to imagine browsing deer pushing rare plants closer to extinction. The Pine Bush Management Plan calls for monitoring the deer population and managing it by permitting hunting. Surging numbers of foraging turkeys may also be causing ecological problems by seriously depleting the seed bank of native Pine Bush plants.

## Loss of Native Species

The Albany Pine Bush supports more than 50 rare and imperiled species. Many of these, and many of the species that have disappeared from the Pine Bush landscape, live in wetlands or open, sandy areas. The primary threats to these species have already been discussed: habitat loss and degradation, habitat fragmentation, fire suppression, wetland and aquifer degradation, and invasions of aggressive species. In addition to these, pesticides have been, and remain, a significant threat to many species.

In the absence of wildfires and other natural disasters, railroads, powerlines, and other rights-of-way provide open, disturbed habitats that are essential to the survival of many plant species. Herbicide applications used to keep these rights-of-way open endanger some susceptible species, such as the sedges *Cyperus houghtonii* and *C. odoratus*. Certain insect species that have not been seen since the 1950s, such as *Acronicta albarufa*, might be victims of widespread and imprudent insecticide spraying, especially DDT. The giant silk moth, *Citheronia sepulcralis*, whose larva, known as the pine devil, feeds on pitch pine, has disappeared from the Pine Bush. Its spectacular relatives, the regal moth or royal walnut moth (*C. regalis*) and the imperial moth (*Eacles imperialis*) both started to disappear from New York State in the 1950s, apparently due to pesticide spraying for the gypsy moth, an introduced and highly destructive forest pest.

Of course rare species greatly enhance the value of the Pine Bush, and they argue strongly for its conservation, but they make management a difficult task. Restoring historic fire and hydrologic regimes to the ecosystem should help to restore degraded native plant communities. Loss of some native species, such as lupine and pitch pine, may be remedied by programs of seeding and transplanting aimed at reestablishing the native communities on disturbed sites. Restoration of native plant species should help to stabilize populations of native animals, such as the Karner blue butterfly and other butterflies and moths. Before starting a management program at a site, a rare species survey should be conducted. To minimize adverse impacts on rare plants and animals, areas supporting these species must be managed so that remnant populations survive prescription burning or other management techniques and are able to recolonize treated areas.

In the following article, Pine Bush ecologist Neil Gifford discusses ecology and management challenges in the case of the Karner blue butterfly.

## Karner Blue Butterfly (*Lycaeides melissa samuelis*)

*by Neil A. Gifford, Albany Pine Bush Preserve Ecologist*

The Albany Pine Bush is home to a wide variety of wildlife species, the most famous of which, the Karner blue butterfly, is also one of the rarest. Twenty years ago thousands of Karner blue butterflies could be seen during their summer flight season throughout the Pine Bush; currently the entire population is estimated at 1,000 adult butterflies in a few small isolated subpopulations. The Karner blue is a state and federally listed endangered species. Efforts to recover the Karner blue from the brink of extinction are being made by the Albany Pine Bush Preserve Commission, The Nature Conservancy, the New York State Department of Environmental Conservation, and the U.S. Fish and Wildlife Service. Protecting this symbol of the Pine Bush landscape for future generations will depend on our ability to restore and maintain what remains of the once vast inland pitch pine–scrub oak barrens.

### *Fire, Lupine, and the Karner Blue Butterfly*

The Karner blue subspecies of the Melissa blue butterfly was described from Karner, New York, specimens in 1943 by author and lepidopterist Vladamir Nabokov. Karner was a small rural area just west of the City of Albany amidst 25,000 of acres of pitch pine–scrub oak barrens. Relatively frequent wildland fires swept across the area maintaining the barrens and creating a patchwork of burned and unburned areas. Open sandy areas created by these fires or other disturbance events were colonized by early successional plants, including the wild blue lupine and other prairie wildflowers and grasses.

Because the Karner blue butterfly does not fly long distances, and its only known larval food plant is wild blue lupine, it is generally confined to areas that contain lupine. Larvae eat primarily lupine leaves but have been known to feed on other lupine parts.

Wild blue lupine is a relatively shade intolerant, long-lived perennial belonging to the pea family. Like many plants in the pea family, lupine has an obligate bacterial root association, essential for nitrogen fixation. Typically found in open, sunny, dry sites, wild blue lupine is believed to have been historically maintained by periodic wildland fires and is thus a disturbance-oriented, early successional perennial. Lupine has declined dramatically in New York State over the past 15 years due largely to urbanization and the exclusion of natural fire and other disturbance processes beneficial to the plant. Without disturbance to maintain a mosaic of open areas, wild blue lupine plants decrease in vigor and are out-competed by more shade-tolerant species. Karner blue butterfly populations are in serious decline primarily due to the loss of this critical plant species. Although no Karner blue life stage (egg, caterpillar, chrysalis, or adult) can survive fire, the patchwork of open areas created and maintained by wildfire would be colonized by surviving butterflies from nearby unburned patches.

The loss of habitat and the exclusion of natural fires in the Pine Bush have eliminated many acres of suitable Karner blue habitat. As a result of the declining habitat, Karner blue populations in the Pine Bush, and throughout their range, declined. In 1977 the Karner blue was listed as endangered by New York State law and was subsequently protected under provisions of the federal Endangered Species Act in 1992. Currently the overall observed numbers of adult Karner blue butterflies in the Pine Bush remain relatively constant with seasonal and annual fluctuations at various sites. The Karner blue butterfly still occurs in remnant, isolated pockets of open savanna and pine barrens habitat in New York, Indiana, Michigan, Minnesota, and Wisconsin. It is believed to be extirpated from Ontario, Maine, New Hampshire, Massachusetts, Connecticut, New Jersey, Pennsylvania, Ohio, and Illinois (Baker 1994). In addition to the Pine Bush, three other areas support remnant Karner blue populations in New York State. Karner blues can still be found at the Saratoga Sandplain (Wilton Wildlife Preserve and Park), Saratoga Airport, the Queensbury Sandplain, and the Tonawanda Indian Reservation in Genesee County.

*continued*

### KARNER BLUE BUTTERFLY, *continued*

#### *Karner Blue Butterfly Biology*

Karner blue butterflies have two broods each year. The spring-brood adults typically fly from late May to mid June, while the summer-brood adults fly from mid July to early August.

First-brood adults nectar almost exclusively on lupine because of its relative abundance at most sites. Lupine flowers generally go to seed by the time of emergence of the second butterfly brood, and, consequently, second-brood adults nectar on a variety of flower species. Butterfly-weed (*Asclepias tuberosa*), New Jersey tea (*Ceanothus americanus*), and dotted horsemint (*Monarda punctata*) are favored nectar sources. Native prairie grasses are also an important component of Karner blue habitat, providing sheltered roosts at night and during inclement weather.

During the active flight seasons, male Karner blue butterflies tend to emerge before females, with adults of both sexes living an average of 4–5 days. Adult Karner blues are active from sunrise to sunset, flying relatively slowly and close to the ground in an irregular pattern. Activity usually decreases in cool, windy, and rainy weather. Although Karner blues have been seen flying in a light rain, during heavy rain and thunderstorms they take refuge under vegetation.

#### *Management and Recovery*

The Albany Pine Bush is identified as a state and federal Karner blue butterfly recovery unit, essential to the successful recovery of the subspecies. The creation of the Albany Pine Bush Preserve is partially attributed to the presence of the Karner blue butterfly here. Since 1991 The Nature Conservancy, the New York State Department of Environmental Conservation, and the Albany Pine Bush Preserve Commission have monitored populations of Karner blues throughout the Pine Bush. Working with the state and federal Karner blue butterfly recovery teams, a detailed plan for Karner blue recovery in New York State is currently being prepared. That plan will identify a set of minimum viability criteria and a recovery strategy to recover and delist the Karner blue from state and federal endangered species lists.

Recreating and maintaining within the Preserve a functional set of local populations connected by migrating individuals (a metapopulation) will be challenging. Existing habitats must be expanded, large areas of new habitat must be created, and "stepping stones" must be established, effectively linking areas of Karner blue butterfly habitat. Roads and commercial and residential development are barriers to butterfly dispersal. Many developed areas lack lupine and nectar plants.

The successful recovery of the Karner blue butterfly will require the continued cooperation of various state, federal, and private conservation agencies. It also depends on involvement of the general public. The Albany Pine Bush is highly fragmented by many roads and commercial and residential development. Property owners in these areas can help protect the Karner blue by planting lupine and other native plants, eliminating invasive plants, volunteering with The Nature Conservancy and the Albany Pine Bush Preserve Commission, and informing others about the importance of Karner blue butterfly protection.

For information on how you can help protect the Karner butterfly, contact the Albany Pine Bush Preserve Commission (Latham, NY; (518) 785-1800; APBPC@aol.com).

## Recreation and Education

The Management Plan for the Albany Pine Bush addresses the issues of recreation and education. Pine Bush vistas, the sharp contrast between this relatively wild area and adjacent urban development, and a feeling of remoteness contribute to the area's appeal as a passive, low-impact, trail-oriented recreational area. Interesting features of the Preserve include its unique

ecosystem, the influence of fire, the dune topography, and its streams and other water features. The Management Plan calls for the provision of a wide variety of uses compatible with ecological resources and ecological management goals. Control of illegal and undesirable uses of the Preserve, such as dumping and use of off-road vehicles, is necessary. The most harmful form of outdoor recreation is use of off-road vehicles. Motorized recreational vehicles accelerate dune erosion, destroy vegetation, harass wildlife, and contribute to loss of rare habitat. The Management Plan also calls for sharpening public awareness and appreciation of Pine Bush ecology and fire management through educational programs and publications and development of an interpretive center associated with the Preserve.

In the following article, Preserve Education and Outreach Director Erin Kinal discusses opportunities for recreation and education in the Albany Pine Bush.

## Recreation and Educational Opportunities in the Albany Pine Bush

*by Erin M. Kinal, Albany Pine Bush Preserve Education and Outreach Director*

### *Recreation*

Recognized nationwide as a biologically unique area, the Albany Pine Bush Preserve is within close proximity of several Capital District region housing developments, schools, and a variety of businesses. The Pine Bush is literally in the backyards of hundreds of Albany County residents. Few other urban or suburban areas in the United States harbor such unique ecological diversity so close to urban development.

In addition to serving its primary purpose as an ecological sanctuary, the 2,750-acre Albany Pine Bush Preserve offers numerous recreational opportunities for the public. A variety of trails, altogether totaling almost 20 miles, traverse the varied terrain of this landscape, from the arid pitch pine–scrub oak barrens to the seasonally damp vernal ponds to the deep ravines that wind through portions of the Preserve. Trailheads with informational kiosks located throughout the Preserve provide several different public access points to this trail system.

The Albany Pine Bush Preserve is open year-round for passive, nonmotorized recreational use (motorized vehicles are strictly prohibited). Many area residents come to the Pine Bush for hiking, jogging, bird watching, hunting, or cross-country skiing. The Albany Pine Bush Rensselaer Lake Preserve and Park (formerly known as Six Mile Waterworks), an Albany city park popular for picnicking and fishing, is also part of the Pine Bush Preserve and is open for public use. Public access and use of the Preserve is encouraged provided that ecological resources are not threatened. *Please note, when visiting the Albany Pine Bush Preserve, stay on the marked trails and avoid picking or otherwise damaging the plants and animals that live there.* Trail maps are available upon request at the Albany Pine Bush Preserve Office, 108 Wade Road, Latham, NY 12110; (518) 785-1800.

With the exception of the Rensselaer Lake Preserve and Park, the Albany Pine Bush Preserve employs a "carry it in–carry it out" philosophy. *continued*

## Recreation and Educational Opportunities in the Albany Pine Bush, *continued*

### *Education*

The Albany Pine Bush also offers numerous educational as well as recreational opportunities for the public. Targeted as a site of outstanding biological significance, the Pine Bush is an excellent outdoor classroom for people of all ages.

Several local schools, ranging from elementary schools to local colleges, visit the Pine Bush annually to conduct ongoing innovative scientific research. Many schools also come to the Pine Bush for guided interpretive walks. Monthly field trips, led by local experts, provide the public with opportunities to learn about the ecology of the Pine Bush as well.

The Albany Pine Bush Preserve Commission plans to establish an interpretive Discovery Center in the Pine Bush to help achieve the goal of creating greater public awareness and appreciation of Pine Bush ecology and management, including the fire management program.

An expanding number of individuals, groups, and classes would like to take advantage of the educational and recreational opportunities the Pine Bush offers but have no formal place to go for information. The proposed Discovery Center will provide a central location where visitors can obtain interpretive information on the ecological and biological, historical, and recreational aspects of the Albany Pine Bush. The center will also provide a meeting place for public programs and facilities to assist with ongoing research in the Preserve. In 2001 a land exchange was arranged, in which the State of New York will receive 11.5 acres (4.7 ha) of Pine Bush land and the State Employees Federal Credit Union (SEFCU) headquarters building on New Karner Road, adjacent to the Karner Barrens East portion of the Preserve. The SEFCU headquarters building is expected to serve as the new Pine Bush Discovery Center. SEFCU will take title to 7.2 acres (2.9 ha) at the Harriman State Office Campus.

A satellite interpretive center has also been proposed for the Rensselaer Lake Preserve and Park. The City of Albany recently adopted a plan to restore and revitalize this city park with an emphasis on recreational and educational opportunities while promoting the unique attributes of the Albany Pine Bush.

# Species Synopses

### Sandy Laccaria

*Laccaria trullisata* (Ellis) Peck
Basidiomycetes: Tricholomataceae

Cap 1.0–2.5 inches (2.5–6.5 cm) in diameter; grayish purple when young, brown or reddish brown when mature; gills purple, thick, waxy, attached to stalk, but neither notched nor extending down stalk; stalk 1.2–3.1 inches (3–8 cm) tall, pink to brown, covered with embedded sand grains.

These infrequent but widely distributed and distinctive mushrooms are conspicuous in deep, exposed sand along Pine Bush trails a day or two after late summer or autumn rains. They are often found in clusters of two or three. The stems are often buried in sand. The sandy laccaria is regarded as edible but rather tasteless and not very desirable (Bassette et al. 1997; Miller 1977).

### Barometer Earthstar

*Astraeus hygrometricus* (Persoon) Morgan
Gastromycetes: Lycoperdales

Fruiting body 0.4–1.2 inches (1–3 cm) in diameter, round; outer skin splitting into 7–15 pointed, hygroscopic rays that open up and flatten out when wet, but close around spore sac when dry; inner ray surface conspicuously cracked; spore sac with irregular pore-like mouth and finely roughened surface; mature spore mass dark brown.

This little earthstar, a relative of puffballs, is usually found in sandy soils, and it is one of the world's most widespread fungi. It is fairly abundant in recently disturbed, exposed, sandy dune areas of the Pine Bush (Dirig 1986a). Barometer earthstars are also characteristic of dry pine barrens habitats in Saratoga and Warren Counties. They are composed of layers surrounding a central sac filled with millions of spores. The outer layer is very strong and water resistant, while the inner layer soaks up water and swells until the outer layer splits into rays like a starfish and turns inside out. As it does this, the earthstar pulls away from its root-like underground network of mycelia. While the fungus is moist it sits on the tips of its rays, but as it dries it folds up into a sphere again and is blown around by the wind. It often lasts a year or more alternately sitting and rolling. Barometer earthstars are considered inedible.

## Common Hair-cap Moss

*Polytrichum commune* Hedw.
Polytrichales: Polytrichaceae

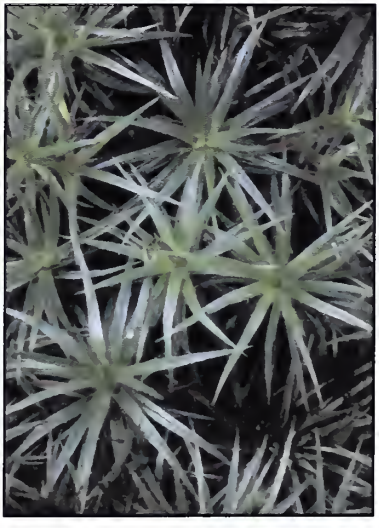
Plant tall, up to 1 foot (0.3 m); leaf very long, often 0.5 inch (13 mm), flat, with margin serrate, not folded inward; leaf apex neither red nor prolonged into a hair-point; leaf base exposed and shiny.

This common and nearly cosmopolitan moss typically grows in wet places, at the edges of swamps or bogs, but it is also found on dry soil or humus, under trees, and on mildly acid soils, often in full sun.

Mosses are important in dune colonization, helping to stabilize the sand, adding organic material, and keeping the surface moist. *Polytrichum* species are rather tall mosses with hard or woody stems. They are found in extensive and luxuriantly green patches along paths and in other open areas. The movement of water in mosses is mostly external, but *Polytrichum* species also possess well-developed internal water-conducting tissues that transfer water from the base of the moss cushion to the photosynthesizing leaves at the apex. During dry periods, the mosses become brown and unattractive. They turn their leaves upward, so that only their thick and impervious undersurfaces are exposed, and the delicate upper surfaces face the stem. *Polytrichum* species often follow a pioneer moss community in burned-over habitats, as nutrient levels decrease due to leaching. In England and elsewhere, hair-cap mosses were used in the construction of early beds, baskets, ropes, brushes, and doormats (Crum 1983; Crum and Anderson 1981; Marshall 1910; Richardson 1981).

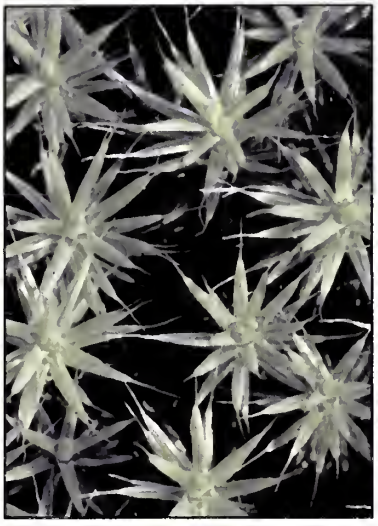
## Juniper Moss

*Polytrichum juniperinum* Hedw.
Polytrichales: Polytrichaceae



Plant short, 0.5–5.0 inches (1.3–12.7 cm) tall, in loose reddish-brown or bluish-green tufts; leaf often bluish and resembling a juniper scale when moist, without marginal teeth; leaf margin folded inward and completely covering upper, photosynthetic leaf surface; leaf apex brown or red, not prolonged into hair-point. Plants are larger than those of *P. piliferum*.

This is the most common and widespread moss in the genus *Polytrichum*. It occurs on well-drained, acidic soils and is characteristic of banks or sides of trails in dry, open areas. It often occurs in areas ravaged by fire. In the New Jersey Pine Barrens, juniper moss is one of the prominent mosses on sites that burn annually. Juniper moss can emerge from deep burial under shifting sands of open dune habitats, but it is slower to establish itself than some other dune mosses, and it is absent early in dune succession. In the Albany Pine Bush, it occurs in areas with high water tables in the pitch pine–oak forest and red maple–hardwood swamp communities.



## Awned Haircap Moss

*Polytrichum piliferum* Hedw.
Polytrichales: Polytrichaceae

Plant short, 0.5–1.5 inches (1.3–3.8 cm) tall, in loose brown or bluish-green tufts; leaf without marginal teeth; leaf margin folded inward and completely covering upper photosynthetic leaf surface; leaf apex prolonged into grayish white hair-point or awn. This is the smallest member of the genus *Polytrichum*, and the leaves are crowded into a short tuft at the end of the stem. This growth habit and the elongate white awns give the plant a distinctive character.

Awned hair-cap moss occurs around the world, from Greenland to Antarctica. It is a pioneer of dry, sterile, acidic, sandy or gravelly soil. It occurs in situations similar to those of *P. juniperinum* but is generally less common. In the Albany Pine Bush, it can be found in sandy soil and rotting logs in pitch pine–oak forest, along unpaved roads and paths, and in sand mines. It is often listed among the early colonists on freshly burned habitats, and it has been known to become a dominant species two to four decades after fire.

## Bracken

*Pteridium aquilinum* (L.) Kuhn ex Decken
Polypodiales: Dennstaedtiaceae (Bracken Family)

A fern, 1–4 feet (0.3–1.2 m) tall; fronds stout, strong, 8–40 inches (0.2–1.0 m) high; stalk smooth, woody, dark at base, light above; blades triangular, flat, often almost horizontal, 5–20 inches (13–51 cm) long, often divided into three equal parts; rhizomes long, creeping, deep in soil.

Bracken, or brake, is a coarse, weedy fern that grows in dry, sandy, acidic soils of fields and open woods—conditions that most ferns could not tolerate. It occurs around the world in temperate and tropical regions. In the Pine Bush, it is the most common upland fern and a major component of the undergrowth of open pine woods. Its uncoiling fiddleheads are among the first plants to appear through the scorched soil after a fire. Smooth, rigid leaf stalks emerge at intervals from stout, spreading, underground rootstock. Spores are borne in late summer beneath the outer margins of the frond divisions (pinnules). However, except in moist coastal regions, establishment through spore germination is rare. Spore germination apparently requires soil sterilization and the alkaline conditions produced by fire. Most regeneration is vegetative, and rhizomatous clones can be many hundreds of years old. The first autumn frost kills the fronds, which then turn brown and crisp. Dead fronds insulate the rhizomes from frost and delay emergence of frost-sensitive fiddleheads in the spring, but they are highly flammable. Bracken promotes fire, but it is also well adapted to fire, primarily because of its deep rhizomes, which sprout vigorously before competing vegetation can re-establish itself. It competes effectively for soil moisture and nutrients, and it shades out small plants. Fossil evi-

dence suggests that bracken has had at least 55 million years to evolve chemical defenses against diseases, insects, and other threats. Through release of allelopathic chemicals, it can inhibit seed germination and seedling growth in certain competing species, such as black cherry. Leaves and roots contain thiaminase, which results in vitamin $B_1$ deficiency in nonruminants, such as horses and swine. Acute bracken poisoning affects the bone marrow of cattle and sheep and causes anemia and hemorrhaging, which is often fatal. Some fronds release hydrogen cyanide when damaged. Bracken has been found to be mutagenic and carcinogenic in rats and mice, usually causing stomach and intestinal cancer. However, the fiddleheads, which are said to taste like asparagus, are still consumed by some cultures. This fern has been reported as the host plant for caterpillars of a number of arctiid, noctuid, and geometrid moths, although the presence of insect molting compounds in bracken may explain its general resistance to insect feeding (Tietz 1972; Tryon and Tryon 1982). Formerly, bracken was widely used as a source of fuel, potash for making glass and soap, roofing thatch, packing material, livestock bedding, ground cover, medicine, and food (Frankel 1981).

## Tamarack, American Larch

*Larix laricina* (DuRoi) Koch

Pinales: Pinaceae (Pine Family)

A small to medium-sized tree, 40–80 feet (12–24 m) high, with long, cylindrical trunk and open conical crown; needles 0.8–1.0 inches (2.0–2.5 cm) long, three-angled, soft, in clusters of 10–20 at ends of twig spurs and scattered along longer branches, turning yellow before being shed in autumn; cones 0.5–0.8 inches (1.3–2.0 cm) long, lacking prickles, with few, thin scales; bark dark, thin, smooth when young, flaking off in small scales with age; root system shallow and wide spreading.

Tamarack commonly occurs in the cold, wet, peaty soils of bogs and swamps across northern North America and south to northern New Jersey and Minnesota, although it grows best on well-drained, moist, loamy soils with a shallow surface layer of organic matter. It is near the southern limit of its range in the Albany Pine Bush. Only a handful of specimens can be found here, all of them clustered in a small, forested, wetland section of the King's Highway Barrens. Tamarack is intolerant of shade and must be in the overstory to survive when mixed with other species. Seedlings require nearly full sunlight to survive and grow well. It seems likely that without significant management effort, the Pine Bush population will disappear in the near future. Tamarack trees, because of their thin bark and shallow roots, are easily killed by fire, but the species is well adapted to reproduce successfully on burn sites, especially burned organic soil.

## Pitch Pine

*Pinus rigida* Mill.

Pinales: Pinaceae (Pine Family)

A medium-sized tree, 40–60 feet (12–18 m) high, often irregular, gnarled, flat-topped, with long, spreading branches; needles 3–6 inches (8–15 cm) long, coarse, stiff, in bundles of three; cones stout, 0.8–2.8 inches (2–7 cm) long, with sharply tipped scales, often in clusters and remaining many years on tree; bark dark reddish-brown to black, broken into thick, irregular plates.

Pitch pine has a spotty distribution in the Northeast and the Appalachians. It ranges from southern Maine, extreme southern Ontario and northern New York southwest to northern South Carolina, northern Georgia, and eastern Tennessee. It grows on poor, acidic soils, including the sandy soils of Cape Cod, Long Island, and New Jersey and the shallow soils of steep slopes, ridges, and plateaus. At most sites where pitch pine is common, the soils are very low in nutrients, but trees respond well to fertilization, leading to the conclusion that they are restricted to poor soils in nature because competition from other species eliminates them in richer sites. Pitch

pine can tolerate a wide range of moisture conditions. On dry sites, trees develop deep roots, reaching as far as 8–9 feet (2.4–2.7 m) down. In saturated soils, roots live and grow below the water table.

In the Albany Pine Bush, pitch pine is the dominant tree in the pitch pine–scrub oak community, which is maintained by fires with a frequency of at least every 20 years. It is a dominant in pitch pine–oak forest, where it occurs in association with a number of oaks, aspens, cherries, and other tree species on sites that have not burned recently. Pitch pine can also be found in low interdunal vernal ponds with red maple, gray birch, and quaking aspen. It is a component of Appalachian oak–pine forests in the sandy ravines of the Pine Bush, where it occurs in association with oaks, red maple, hemlock, beech, and black cherry, and it is a component of successional hardwood forests, which are often dominated by poplars, cherries, and black locust on dunes that have not burned regularly.

Pitch pine is flammable and easily top-killed by fire, but it is unusual among pines in its ability to survive fire and other damaging agents. If all foliage is killed by fire, the crown can still produce new needles, and if the stem is killed, spouts can emerge from the base. The thick bark of older trees protects dormant buds and the cambium layer, allowing individuals to regenerate after fire. Pitch pine seedlings have very high photosynthetic rates, and trees produce seeds at an early age (4–12 years), allowing the species to withstand frequent fires (Ledig and Little 1998). In seedlings, a basal crook in the stem keeps lower dormant buds in contract with the ground and thus protected from fire damage.

Pitch pine is monoecious, with stamens and pistils in separate flowers on the same plant. Pistillate flowers are often on higher branches than staminate flowers. The yellowish to purplish staminate flowers shed pollen in May. Cones mature from pistillate flowers at the end of the second summer. Cone and seed production are irregular.

Individual trees produce either cones that open and release their seeds as soon as they mature, or serotinous cones that can remain closed for many years until fire melts the resin that binds them, allowing them to open and release their seeds at a time when competing vegetation is eliminated and a mineral seed bed is exposed. In the Albany Pine Bush, where natural fire frequency is about every 20 years, no serotinous cones are produced. Cryptic insect damage can prevent nonserotinous cones from opening, leading to the false conclusion that these are serotinous cones. In areas of the New Jersey Pine Barrens where fire frequency is 6–8 years, nearly all dwarfed pitch pines have serotinous cones. Cones close during wet weather and reopen during fair weather when westerly winds predominate, distributing most seeds to the east of the parent tree. Pitch pine seeds require mineral soil for germination. When fire exposes mineral soil, seeds released from cones germinate and seedlings establish during the first growing season after the fire. Seedlings grow slowly for the first several years, while the deep taproot is developing. Deer browsing and hardwood competition further reduce the growth rate of pitch pine.

Although pitch pine is usually considered intolerant of shade and competition, there is some evidence that survival of naturally recruited pine seedlings is higher under scrub oak than in areas where the oak has been removed. Experiments have shown that seedlings transplanted under scrub oaks have much higher survival than seedlings in the open, and survival of transplants is higher in unburned than burned sites. Seed predation is more intense in burned sites than in unburned sites (Fang et al. 1998). Herbivory also affects seedling survival. Many birds, white-footed mice, and squirrels consume the seeds, sometimes at such high rates that postfire seedling establishment is inhibited. Only in the infrequent years of good production is there enough seed to be more than food for small mammals, birds, and insects. The recent arrival of the western conifer seed bug (Coreidae: *Leptoglossus occidentalis*), first found in the Pine Bush in 1995, further reduces the reproductive capacity of pitch pine. Deer, rabbits, mice, and voles feed on seedlings and sprouts, but seedlings clipped to within an inch or two of ground level can still live.

Micorrhizae are a common feature of pitch pine roots. Pitch pine seedlings transplanted into Albany Pine Bush sites dominated by black locust die at much higher rates and have much lower mycorrhizal species diversity and inoculation rates than seedlings transplanted to sites dominated by typical pine barrens vegetation (Gill 1998).

There is evidence that acid rain and air pollution are contributing to a recent decline in pitch

pine growth rates (Johnson et al. 1981; McClenahen and McCarthy 1990; Schier 1987).

Pitch pine hosts the eastern pine elfin, *Incisalia niphon*, the northern pine sphinx, *Lapara bomycoides*, the noctuid moth *Zale submediana*, and the lymantriid moth *Dasychira pinicola*. The giant silk moth, *Citheronia sepulcralis*, whose larva, known as the pine devil, feeds on pitch pine, has disappeared from the Pine Bush, as has the noctuid *Lithophane lepida*. Pitch pine tip moths, pitch pine loopers, sawflies, southern pine beetle, pine webworm, and pine needleminer periodically damage pitch pine stands.

Before the Revolution, pitch pine was a source of tar and turpentine. Pitch pine wood resists decay because of its high resin content, and so it was once important for shipbuilding, fencing, railroad ties, and water wheels for gristmills. The wood was also used in firing steam engines because its resins fuel a hot fire. Today it is used for rough construction, pulp, crating, and fuel.

## Scarlet Oak

*Quercus coccinea* Muenchh.

Fagales: Fagaceae (Beech Family)

A large tree, 60–80 feet (18–24 m) high; leaves 3–6 inches (8–15 cm) long, shiny above, smooth below, often with hairs in vein angles; deeply lobed and cut nearly to midrib, with lobes bristle tipped; twigs with end buds scraggly hairy, often whitish tipped; acorn nuts enclosed for one-third to one-half of length in bowl-like cups bearing tightly appressed scales; nuts often with one or more concentric, incised circles near apex; bark finely grooved, dark brown to black. Scarlet oak is distinguished by its shiny leaves with deep sinuses between bristle-tipped lobes, and the concentric circles often found at the tips of the acorns.

Scarlet oak is a fast-growing, short-lived, upland species. It grows from southern Maine to Georgia in the East, and from southern Michigan south to southern Missouri and Mississippi. The northeastern portion of its range corresponds closely with that of black oak, and the Albany Pine Bush is near the northwestern edge of that range. Scarlet oak occurs most commonly on dry, sterile, sandy soils. It is best represented in forests with a history of disturbance, such as fire, logging, grazing, or disease, and it is a common component of pine forests. The trees have thin bark, and low-severity surface fires can severely damage them, but top-killed scarlet oaks sprout vigorously from the well-developed root systems after fire, and these sprouts are able to compete more successfully than seedlings. Like black and red oak, scarlet oak is not common in the pitch pine–scrub oak community because it does not produce viable seed at a young enough age to become established in areas that burn frequently. These oaks are usually restricted to the later successional forests. Scarlet, red, and black oaks are susceptible to a number of insects and diseases. Oak wilt and shoestring root rot can kill trees damaged by fire and other agents. Defoliating insects, including gypsy moth, oak leaftier, variable oakleaf caterpillar, orangestriped oakworm, browntail moth, and forest tent caterpillar, can kill trees through repeated defoliations. Other insects tunnel into the wood, providing entry points for pathogens. Root-feeding and gall-forming insects further reduce the vigor of oak trees. Scarlet oak is named for its brilliant red autumn foliage, and the trees are widely used as ornamentals.

## Red Oak

*Quercus rubra* L.

Fagales: Fagaceae (Beech Family)

A large tree, 65–98 feet (20–30 m) high; leaves 4–10 inches (10–25 cm) long, thin, dull green above, hairless below, with 7–11 pairs of bristle-tipped lobes; twigs with end buds hairless, not sharply angled; acorn cup flat, shallow, saucer-like, very short stalked; bark dark, furrowed, with broad and flat ridges, often laced with broad, shiny strips. Red oak is easily distinguished from black oak by its dull leaves and shallow, saucer-shaped acorn cup.

Red oak is the tallest and fastest-growing oak. It occurs from Nova Scotia to Georgia and Alabama, and from Minnesota to Oklahoma and Arkansas in a wide variety of circumstances, from rich woods to sandy and gravelly soils. It is less drought resistant than black oak, but it has about the same level of shade tolerance. Plants generally exhibit best growth on deep, fertile, well-drained, finely textured soils with a relatively high water table. The species is neither an aggressive, early-succession colonizer nor an enduring, shade-tolerant, late-succession species. In the Pine Bush, it occurs in the pitch pine–oak forest community, pine–northern hardwood forest, and red maple–hardwood swamp community. Older, larger trees often survive fire, and young, small trees typically resprout vigorously from the stump or root collar. Postfire seedling establishment has also been reported. Because of fire suppression, red oak is often replaced by more shade-tolerant, fire-susceptible species such as maple and basswood. Red, black, and scarlet oaks bloom in April or May, before or while the leaves are emerging. Male, or staminate, flowers develop from axils of the previous year's leaves, and female, or pistillate, flowers are borne in the axils of new leaves. Acorns ripen in late summer or fall after their second growing season and germinate the following spring. They are very bitter but highly palatable to many animals. Squirrels, mice, blue jays, and other animals disseminate them, and some cache acorns in the soil. The acorn crop is in such high demand as food for insects, turkeys and other birds, squirrels, and small rodents that it is seriously diminished in most years. In a typical year, 80–100 percent of the crop may be destroyed. A single turkey can consume more than 200 acorns at one "meal." Gray squirrels bury up to 20 percent of the acorn crop and fail to recover many seeds over the winter. Blue jays can transport acorns 2 or 3 miles from the parent tree and cache them in open sites or at forest margins. Red oak is an important source of firewood and strong, coarse-grained hardwood lumber. For commercial purposes, the lumber is mixed with that of other "red oaks," including *Quercus velutina*, and is used for furniture, flooring, and interior finishing. Red oak is also a popular shade tree with good form and dense foliage.

## Black Oak

*Quercus velutina* Lam.

Fagales: Fagaceae (Beech Family)

A large tree, 70–80 feet (21–24 m) high; leaves 4–10 inches (10–25 cm) long, broadest above middle, leathery, glossy dark green above, slightly hairy below, especially at angles where veins join midrib, with five to seven pairs of bristle-tipped lobes; twigs with end buds gray hairy and sharply angled; acorns enclosed for one-third to one-half of length in thin, bowl-shaped cups with sharp, pointed scales forming loose fringe at rim; bark rough, ridged, almost black. The large, glossy leaves, which are hairy below, and the shaggy acorn cups distinguish black oak.

Black oak occurs from southern Maine to northern Florida in the East, and from Minnesota to Texas farther west. In the Albany Pine Bush, it is near the northern limit of its range. Although it grows best on moist, rich, well-drained sites, this moderately shade-intolerant tree is sensitive to competition in these areas. Low nutrient requirements, a deep taproot, and deep and wide-spreading lateral roots allow it to use dry, poor soils. Black oak, like red and scarlet oak, is best represented in forests with a history of disturbance, such as fire or wind-throw. Early land surveys indicate that white oak–black oak–hickory forest was prevalent prior to forest clearing and fire suppression in the Hudson River Valley. In the absence of disturbance, these oaks are succeeded by more shade-tolerant, mesophytic species. Seedlings grow slowly, and in the absence of fire they are unable to compete with faster growing species for light and other resources. Oak seedlings that are repeatedly tip-killed develop extensive root systems. Sprouts from the root crown grow faster than new seedlings and are better able to compete successfully. However, black oak does not normally occur in fire-dependent pitch pine–scrub oak communities because it does not produce viable acorns at a young enough age for the species to become established in areas that burn frequently. In the Pine Bush it is found in the pitch pine–oak forest community on dunes in areas that have not burned recently. It is also found in the Appalachian oak–pine forest community in protected, sandy ravines, and in successional northern hardwood forests on fire-suppressed sites that formerly supported pitch pine–scrub oak barrens.

## Basswood

*Tilia americana* L.

Malvales: Tiliaceae (Linden Family)

A medium to large forest tree, 50–130 feet (15–40 m) high; leaves about 3–10 inches (8–25 cm) across, serrate, somewhat heart-shaped, with one basal lobe extending farther along leafstalk than the other; flowers and fruits borne in clusters on long stalks attached to narrow, leaflike bracts; flowers yellow-white, fragrant; fruit a nutlike drupe containing one or two seeds.

This large, fast-growing tree, also known as linden, ranges from New Brunswick and New England to northwestern North Carolina and from southeastern Manitoba south to northeastern Oklahoma and northern Arkansas. Basswood grows best in deep, moist soils, and it is often associated with calcareous soils

of low acidity. In the Albany Pine Bush, it occurs in the pine–northern hardwood forest and Appalachian oak–pine forest communities in ravines. Basswood is a fire-sensitive species with thin bark that is easily damaged. Although basswood usually produces good seed crops, few seeds actually germinate. Shading aids the establishment of seedlings. Basswood sprouts prolifically, and because an extensive root system already exists, a sprout has a better chance of replacing a parent tree than does a seedling of a competing species, such as sugar maple, which is more shade-tolerant. Many insects, including gypsy moth, attack basswood, and mice and voles damage trees by girdling trunks beneath the snow. Basswood is an important honey and timber tree. The soft, light wood is used in many wood products and is valued for hand carving. Basswood is also planted as a shade tree in urban areas.

## Big-toothed Aspen

*Populus grandidentata* Michx.

Salicales: Salicaceae (Willow Family)

A small or medium-sized tree, 30–40 feet (9–12 m) high; leaves 2–6 inches (5–15 cm) long, woolly white beneath when young, with 5–15 pairs of large, coarse teeth; leafstalks flattened; twigs with end buds hairy; bark smooth, gray-tan or yellow-green, becoming darker and furrowed with age; flowers typically unisexual, in catkins, wind pollinated. Big-toothed is distinguished from quaking aspen by its slightly larger leaves and large, irregular teeth on the leaf edges.

Big-toothed aspen occurs from Nova Scotia to Kentucky in the East, and from southeastern Manitoba to extreme northeastern Missouri farther west. Both big-toothed and the more common quaking aspen are aggressive, invasive, shade-intolerant species with similar reproductive and fire ecologies. Flowers are borne in drooping catkins up to 3 inches (8 cm) long. Mature catkins have a cottony, caterpillar-like appearance. Flowering occurs early, and seed is dispersed before leaves are fully expanded. Big-toothed aspen tolerates drier conditions than quaking aspen, and large stands are found on sands and sandy loams. Big-toothed and quaking aspen frequently dominate postdisturbance (logging, fire, etc.) forests. In the absence of disturbance, more shade-tolerant conifers and hardwoods eventually replace aspens. The present abundance of aspens in the Pine Bush may be due in part to human disturbances of the environment. Aspen is more common in areas once used for agricultural purposes. Older clones are located in the southern regions of the Preserve, and the trees have spread northward (Austin 1998). Big-toothed and quaking aspen provide food and cover for deer and ruffed grouse. The natural range of ruffed grouse agrees closely with the range of aspens.

Five species of *Populus* are known from the Pine Bush. White poplar, *P. alba*, is a European introduction with leaves white-woolly below, leafstalks rounded, and bark smooth and white. Balsam poplar, *P. balsamifera*, has leaves hairless and fine toothed and leafstalks rounded. The remaining three species have leaves hairless and leafstalks flattened. Cottonwood, *P. deltoides*, has leaves coarse toothed and leafstalks bearing two to three small glands at the base of the leaf blade. Big-toothed aspen, *P. grandidentata*, has leaves coarse toothed and leafstalks glandless. Quaking aspen has leaves fine toothed.

## Quaking Aspen

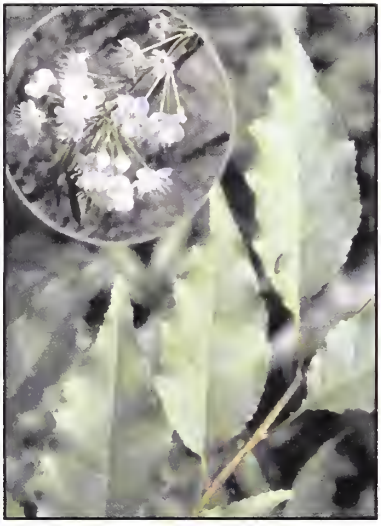
*Populus tremuloides* Michx.

Salicales: Salicaceae (Willow Family)

A small or medium-sized tree, 20–50 feet (6–15 m) high; leaves 2–6 inches (5–15 cm) long, with 20–40 pairs of small, fine teeth; leafstalks flattened; twigs with end buds shiny; mature bark mostly smooth, chalk-white to yellow-green; flowers typically unisexual, in catkins, wind pollinated.

Quaking aspen, also known as trembling aspen, popple, or poplar, is the most widely distributed tree in North America, occurring across most of Canada, northwestern Alaska, the New England and Mid-Atlantic states west to Minnesota, and in the mountains of the West. Because of the flattened leafstalks, even light breezes cause the leaves to flutter or quake. This fast-growing, short-lived, shade-intolerant tree forms clones that may be thousands of years old. It is quick to pioneer disturbed sites where there is bare, well-drained soil rich in nutrients, and it is especially typical of burned-over areas where it commonly forms extensive pure stands. Growth is poor on sandy, dry soils that are poor in nutrients. After about 20 years, aspen, which requires full sunlight, typically becomes crowded and dies out, leaving more shade-tolerant birches and maples, or it is replaced by conifers. The species is dioecious, and trees of a given clone usually bear either all male or all female flowers. Although large seed crops are regularly produced, and viability of fresh seeds is high, few aspen seedlings sprout and survive because of the short period of seed viability and lack of seed dormancy, unfavorable moisture levels for germination, shading of seedlings, and other environmental factors. Vegetative reproduction is more common, with root suckers produced in response to events that disturb or destroy the parent stem or the clone. Roots are known to persist in the absence of an aspen canopy, sustained by transient suckers. Quaking aspen provides food and shelter for many kinds of insects, birds, and mammals.

Quaking aspen is considered an undesirable species in the Albany Pine Bush, because it is aggressive and out-competes rarer species. However, it is difficult to manage. Sucker production is generally proportional to the degree of disturbance. Although thin-barked aspens are highly susceptible to fire damage, stands are of inherently low flammability because of low fuel accumulation, and light burning only stimulates sucker production from fire-resistant roots. Prescribed burning is a management tool used by foresters to regenerate aspen stands. Clearcutting leads to rampant sucker production. Cutting and girdling inhibit the downward transport of sucker-suppressing auxin. However, when stems are cut, cytokinins produced in root tips accumulate in the roots and stimulate sucker production. When trees are girdled, the upward translocation of cytokinins is not impeded, and fewer suckers are produced. Girdling is presently being used as a means to manage aspen stands in the Albany Pine Bush.



## Fire-cherry, Pin-cherry

*Prunus pensylvanica* L. f.

Rosales: Rosaceae (Rose Family)

A shrub or small tree to 20 feet (6.1 m) tall; leaves bright green and shiny above, paler below, finely and sharply saw toothed; leafstalks often with two gland-dots near tip; flowers white, 0.5 inches (13 mm) across, with five petals, borne on long-stalked cluster of four to five flowers; mature fruit 0.25 inch (6 mm) round, bright red; bark reddish brown, nearly smooth, peeling in papery strips.

Fire-cherry is a fast-growing, short-lived tree or shrub that grows from Newfoundland, Labrador, New England, New York, and Pennsylvania (and south in the Appalachian Mountains) west to the Northwest Territories and British Columbia. It occurs on infertile rocky and sandy soils, often in burned areas and clearings in association with aspens and birches. In the Albany Pine Bush, fire-cherry is an important component of the pitch pine–scrub oak community and pitch pine–oak forest. It also occurs along roads and paths, and in the successional southern hardwood forest. Fire-cherry is very intolerant of shade, and it regenerates after wind-throw, heavy cutting, or fire. Seedlings sprout from seeds buried in the forest floor. It has been estimated that some buried seeds can remain viable for as long as 150 years. Aged seeds become more permeable to water and oxygen. Changes in soil and water chemistry, and increased temperature fluctuations following removal of forest overstory by a disturbance, such as fire, trigger increased germination of buried seeds. Flowers bloom during late April and early May in the Pine Bush. The sour but edible fruits ripen in August. Like its relative, black cherry, this species provides food for the caterpillars of many species of butterflies and moths, including the banded or red-spotted purple, and the io and cecropia moths. Adults of the rare Pine Bush bird-dropping noctuid moth *Cerma cora*, which fly in May and June, lay eggs on fire-cherry. Many species of birds and mammals eat the cherries. Fire-cherry is not an important commercial lumber tree.

## Black Cherry

*Prunus serotina* Ehrh.

Rosales: Rosaceae (Rose Family)

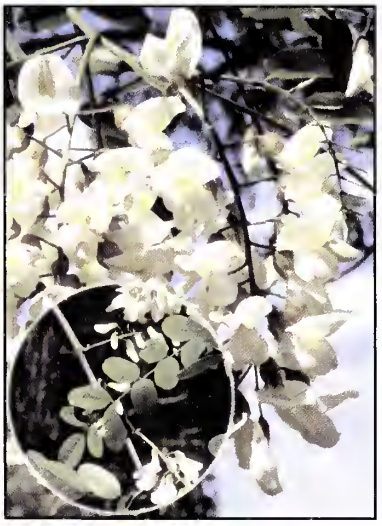
A medium-sized tree, 50–60 feet (15–18 m) tall; leaves 2–6 inches (5–15 cm) long, 1.0–1.5 inches (2.5–3.8 cm) wide, finely serrate with callous, incurved teeth, shining dark green above, pale below and densely haired along midrib near leaf base, hairs pale when young and turning reddish brown at maturity; bark, when young, smooth, dark reddish-brown, marked with long, narrow, horizontal spots, at maturity breaking into scaly plates; flowers white, arranged on short stems along a central axis; fruit dark red to black, fleshy, with a hard stone, about 0.3 inches (8 mm) in diameter, also arranged on short stems along a central axis.

Black cherry occurs from Nova Scotia to Florida and from North Dakota to Texas. It has broad habitat tolerances but tends to do best in moist, deep, rich soils. In the Pine Bush it is common at edges of

wooded areas and in thickets. Black cherry flowers in the spring when the leaves are at least halfway expanded. Fruits ripen and drop by late summer. Long-distance seed dispersal by birds is important in the establishment of black cherry along fencerows and in forest openings, old fields, and pine woods. Black cherry seeds require cold stratification to germinate. This occurs as seeds winter over on the forest floor. Seeds from one crop germinate over a period of 3 years. Black cherry's thin bark has poor insulating properties, and trees are highly susceptible to fires of moderate severity. Trees typically sprout prolifically when aboveground portions are killed by fire. Soil-stored seeds presumably survive at least light fires and contribute to postfire seedling establishment. Because of its abundant soil-stored seeds and prolific sprouting ability, black cherry dominates secondary succession following logging, fire, or wind-throw.

Black cherry bark was used historically as a cough remedy, tonic, and sedative. The fruit was also used to flavor rum and brandy. Pitted fruits are edible, and are eaten raw and used in wine and jelly. Cherries are also much sought after by birds and small mammals in the fall. Black cherry leaves, twigs, bark, and seeds are poisonous to livestock, but deer eat the leaves and twigs without harm. The rich reddish-brown wood is strong, hard, and close grained, making it one of the most valued cabinet and furniture woods in North America.

Fire-cherry or pin-cherry, *Prunus pensylvanica* L., is also common in the Albany Pine Bush after fires in scattered mixtures with aspens and gray birch. Leaves are narrow like those of black cherry but lighter green, thinner, sharp toothed, and lacking hairs below. Twigs have clusters of buds at their tips. Flowers are umbrella-like, and fruit are borne on stems attached at the same point instead of being arranged along a central stem. The fruit is bright red. Chokecherry, *Prunus virginiana* L., is usually a shrub. Its leaves are egg shaped, broadest above the middle, and they are sharply serrate. Flowers and fruit are arranged along a central axis, as in black cherry.



## Black Locust

*Robinia pseudo-acacia* L.

Fabales: Fabaceae (Bean Family)

A medium-sized tree, 40–60 feet (12–18 m) high; leaves compound, with 7–19 pairs of blunt, egg-shaped leaflets; twigs with paired thorns flanking leaf scars; bark thick, deeply furrowed, with interlacing fibrous ridges; flowers white, fragrant, borne on stalks along a central, pendant stem; fruit a flattened legume 2–4 inches (5–10 cm) long.

The natural range of black locust includes the central Appalachian Mountains from central Pennsylvania to northeastern Alabama and the Ozark and Ouachita Mountains of Missouri, Arkansas, and Oklahoma. However, naturalized populations occur throughout the United States and Canada. Black locust flowers in May and June. It can grow on a wide range of sites but does best on rich, moist, limestone-derived soils. It is a shade- and competition-intolerant species and a pioneer and prominent species in old fields and other disturbed sites with no competing woody canopy. It is especially common on sites of abandoned farms and residences in the Pine Bush, and it probably increased following human activities that destroyed living root systems of the shrub oaks originally on the site (Milne 1985). Sprout production, stimulated by damage to the upper parts of the tree, is more important to reproduction than seedling growth. Black locust sprouts quickly from roots and stumps and grows more rapidly than other tree species for the first 10–20 postdisturbance years. In the absence of frequent wildfires that kill young trees, this nonnative species has covered large areas of the Albany Pine Bush, in some areas forming pure stands and displacing pitch pine, scrub oak, and other native species by shading them out and altering soil chemistry (Gill 1998). As a nitrogen-fixing species, black locust can achieve early dominance where nitrogen is

limited, but as soil nitrogen levels rise, shade-tolerant hardwoods can replace it. Other factors in black locust replacement include its short lifespan and lack of reproduction under closed canopies. Nonchemical methods for controlling this unwelcome Pine Bush invader do not work well, because trees tend to sprout again after girdling, burning, and cutting.

Black locust is not an important timber species in the United States, largely because of its poor growth form and frequent locust borer infestations. However, the wood is close grained, strong, hard, heavy, and durable, and it has been used for fence posts, poles, mine timbers, railroad ties, insulator pins, and tool handles. It produces a hot fire and makes excellent fuel wood. The tree is widely planted as an ornamental, for shelter, and for erosion control, particularly on strip-mined lands. Historically it was used as a medicinal plant, but leaves, young shoots, bark, and seeds can be poisonous to humans and domesticated animals. Macerated leaves were once used as a fly killer (Duke 1985). The flowers are a source of nectar for honeybees and hummingbirds.

A related Pine Bush species, *Robinia hispida*, or rose-acacia, is a nonnative, erect, thorny shrub with bristly twigs and rose-colored, pea-like flowers.

## Red Maple

*Acer rubrum* L.

Sapindales: Aceraceae (Maple Family)

Medium-sized tree, 50–90 feet (15–27 m) high; leaf 2–8 inches (5–20 cm) across, whitened and hairy or hairless below, typically three-lobed, sometimes five-lobed; base of terminal lobe wide; sinuses shallow; leafstalk red; flowers and fruits red; twigs and buds reddish; bark smooth and gray on young trees, shaggy and brown on older trees.

Red maple, which occurs from southern Newfoundland to Florida, and from southern Ontario and Minnesota to Texas, is one of the most abundant and widespread trees in eastern North America. Trees have a tendency to develop root system characteristics according to soil conditions, enabling them to grow in moist or wet soils and on dry ridges. In the Albany Pine Bush, red maple is a significant component of most community types, from red maple–hardwood swamp to disturbed pitch pine–scrub oak barrens. It is intolerant of fire, and fire suppression in the Pine Bush has favored its establishment. Postfire mortality of saplings is high, and moderate fires can kill even large trees. However, red maple sprouts vigorously after being top-killed, and sprouts grow faster than seedlings, so this species can also become a more important stand component after fire. Red maple is one of the first trees to flower in the spring, and it is a prolific seed producer. Some trees are entirely male, producing no seeds, and some are entirely female; others are monoecious, bearing both male and female flowers, usually on separate branches. Seeds can germinate under a wide variety of circumstances, including low light. Although young seedlings are more shade-tolerant than early successional species, such as poplar and fire-cherry, few can survive long under a closed forest canopy. Seeds mature in late spring and germinate at once, or they pass the winter and germinate the following spring. The leaves turn brilliant shades of red in the autumn. Deer are known to consume large quantities of red maple during winter.

## Sweet-fern

*Comptonia peregrina* (L.) Coult.
Myricales: Myricaceae (Bayberry Family)

A low, bushy shrub, 1–3 feet (0.3–0.9 m) tall; stem woody, with many branches; leaves long, narrow, deeply lobed, fern-like, with tiny yellow resin dots, fragrant when crushed; catkins 1.2–1.6 inches (3–4 cm) long, at ends of branches; fruits small nutlets surrounded by burr.

Sweet-fern occurs on dry, sandy barrens and pinelands from Nova Scotia to Georgia and Manitoba to Minnesota and Illinois. This distinctive, shade-intolerant inhabitant of poor, sandy soils is not a true fern. It produces long-running rhizomes from which new shrubs can sprout. This habit assists the species in colonizing unstable, blowing sands and areas that have been burned. The deeply buried rhizomes are little affected by even the most severe fires. Catkins appear in late April or early May. Seeds can remain viable in the soil for as long as 70 years. Sweet-fern provides food for caterpillars of a number of noctuid and geometrid moths. Grouse and deer are also known to feed on it. Dried leaves produce a pleasant tea. In folk and Native American medicine, an extract of the aromatic leaves is taken internally to induce labor in childbirth and in milder solution as a tea and to relieve symptoms of dysentery. Because it fixes nitrogen and is drought resistant, sweet-fern is used for erosion control on dry sandy banks, along roads, and under powerlines.

## Scrub Oak, Bear Oak

*Quercus ilicifolia* Wang.
Fagales: Fagaceae (Beech Family)

A large, much-branched shrub or small, scraggly tree up to 20 feet (6 m) tall; leaves 2–5 inches (5–13 cm) long, broadest beyond middle, shining dark green above, silvery-hairy below, with two to five (usually three) broad, pointed, toothed lobes separated by broad, shallow sinuses; acorn enclosed up to halfway by deep cup with stalk-like base, requiring 2 years to mature. Scrub oak is distinguished among Pine Bush oaks by its scraggly, shrubby growth habit and two to five (usually three) broad, pointed lobes on leaves that are broadest beyond the middle.

Scrub oak is distributed from coastal Maine, New England, New York, New Jersey, Delaware, and Maryland west across central and southern Pennsylvania and south through eastern West Virginia and western Virginia. It is an example of an Atlantic Coastal Plain species that probably reached the Pine Bush during a warm postglacial period. This dwarf, scrubby, fire-resistant, and dry-adapted oak commonly forms nearly impenetrable thickets on the poorest of dry, acid soils on sites with a history of recent disturbances, such as cutting or fire. It is often found in mixture with gray birch

or pitch pine. Stems arise from a large, gnarled crown that has several strong roots descending obliquely and deeply into the soil. The shrubs self prune, and a dramatic reduction in the number of stems per plant occurs within a few years. Scrub oak is intolerant of shade, so frequent fire that destroys faster growing species favors its continued abundance. In the Albany Pine Bush, scrub oak and dwarf chestnut oak are the dominant shrubs in the pitch pine–scrub oak community, and they also occur in the pitch pine–oak forest, successional northern hardwood forest, in sand mines, and on brushy, cleared land. Scrub oak flowers from late April to mid May. Leaves turn dull red or yellow in autumn, and many remain attached in winter. The fallen leaves decompose slowly and accumulate in the cluster of stems. This promotes destruction of the aboveground portion of the plant by fire, after which new, vigorous growth replaces the aging crown.

Scrub oak has a legendary ability to regenerate following fire or other catastrophe, with some plants' stems growing to half the length and diameter of the parent plant during the first growing season after stem removal by cutting or burning. Frequent stem removal encourages even more vigorous regeneration, with the possibility that scrub oak could then shade out other species (Weber 1992). Plants growing on south and west facing slopes produce more biomass in post-wildfire regeneration than those growing on valley floors or on north or east slopes (Preston 1992). Acorns are produced on second-year growth following fire and mechanical removal, and the number of acorns per stem peaks 3 to 4 years after fire or other catastrophe (Stewart et al. 1992).

Scrub oak is an important source of nutrition for many Pine Bush animals. Like other oaks, it supports a suite of gall-making wasps (Felt 1940). Caterpillars of the inland barrens buck moth, Juvenal's dusky wing skipper, sleepy dusky wing (no longer found in the Pine Bush), and Edwards' hairstreak consume scrub oak foliage. The rare Pine Bush noctuid moth *Chaetaglaea cerata* lays eggs on scrub oak in autumn. The eggs winter over, and the larvae that hatch in spring feed on new oak buds (Schneider et al. 1991). Birds and mammals consume acorns. In fact, acorns are in such high demand that soon after they ripen the entire crop disappears from the shrubs. The few that might remain are found to harbor grubs of acorn weevils.

## Dwarf Chestnut Oak

*Quercus prinoides* Willd.

Fagales: Fagaceae (Beech Family)

Usually a shrub, 2–10 feet (0.6–3.0 m) tall, occasionally reaching tree size, 18 feet (5.5 m); leaves small, 2.0–3.5 inches (5–9 cm) long, white-hairy below, with three to eight rounded lobes terminating in sharp teeth; mature acorns enclosed a third or halfway up in deep, thin, knobby cups. Dwarf chestnut oak is distinguished among Pine Bush oaks by its shrubby growth habit and three to eight pairs of sharply pointed, shallow lobes per leaf.

Dwarf chestnut oak occurs on poor, dry soils from Massachusetts to North Carolina, and from Minnesota to eastern Texas. It is absent from the boreal pine barrens of northern New York, Maine, and parts of New Hampshire, but rather common in the more southern inland barrens, including the Albany Pine Bush. This scrubby species flowers in May and produces acorns that require only 1 year to mature. Dwarf chestnut and scrub oaks are the dominant shrubs in the pitch pine–scrub oak community, but there is no evidence for competition between these species in the Albany Pine Bush (Martin 1977). The dwarf or shrub oaks of the Pine Bush provide food and shelter for many animal species, including insects, birds, and mammals. They are stoloniferous shrubs with an almost

legendary ability to grow back, even after fire has burned them to ground level. This renewal eliminates diseased and insect-infested old growth and invigorates the plants, leading to greater acorn production. Dwarf chestnut oak, like scrub oak, is a host plant of the inland barrens buck moth. It also hosts soft, thin-shelled oak fig galls, which are often closely pressed together on stems and resemble market figs.

*Quercus prinoides* is a member of the white oak group. Within this group, it belongs to a distinctive subdivision distinguished by leaves that have shallow teeth or lobes. This group also includes chestnut oak (*Q. montana*), swamp white oak (*Q. bicolor*), and (if it indeed grows in the Pine Bush), chinquapin oak (*Q. muhlenbergii*). Chestnut oak occurs in dry woods and has 7–16 pairs of shallow, rounded lobes per leaf, whereas swamp white oak occurs in wet woods and has only four to six pairs of rounded lobes per leaf. Chinquapin oak is a tree with 8–13 pairs of sharply toothed lobes per leaf, whereas dwarf chestnut oak is distinguished by its shrubby growth habit and three to eight pairs of sharply pointed, shallow lobes per leaf. The only other Pine Bush member of the white oak group is white oak (*Q. alba*), a forest tree that has distinctive leaves with rounded, finger-like lobes separated by deep sinuses.

## Hazelnut

*Corylus americana* Walt.

Fagales: Betulaceae (Birch Family)

A large shrub to 10 feet (3 m) tall; leaves 3–5 inches (8–13 cm) long, heart-shaped, double-toothed; leafstalks and twigs with stiff hairs; male flowers dry, scaly spikes to 8 inches (20 cm) long; female flowers tiny, enclosed by bracts, near ends of twigs; nuts acorn-like, enclosed in ragged-edged husks (bracts).

Hazelnut occurs along woodland edges and in thickets from Maine and Saskatchewan south to Georgia, Missouri, and Oklahoma. In the Pine Bush, it is a component of disturbed barrens and disturbed pitch pine–oak forest, and it is found in the understory of other forest types. It is quite common along paths and powerline rights-of-way. Hazelnut reproduces from seed, but more often from its large, woody, shallow rhizomes, which give rise to new shoots close to the parent plant. It can become quite dense when fire is suppressed. The roots and rhizomes can survive low-intensity fires, but they are vulnerable under dry conditions when plenty of fuel is available to produce hot fires. Repeated summer fires can eliminate hazelnut. It is shade tolerant and competes well with hardwoods and pines for light and moisture. Because of its aggressive growth, it is considered a major deterrent to regeneration of upland conifers. Flowers bloom in April or May. By late summer the high-protein nuts, known as filberts, are in great demand by humans, squirrels, chipmunks, deer, grouse, jays, and other birds. Hazelnut is cultivated as an ornamental and for nut production.

Beaked hazelnut (*Corylus cornuta* Marsh.), with smaller leaves, nearly hairless twigs, and nuts enclosed in beaked husks, occurs in the ravines.

## Dune Willow

*Salix humilis* var. *tristis* (Ait.) Griggs
Salicales: Salicaceae (Willow Family)

A low, spreading shrub, to 4 feet (1.2 m) tall; leaves dull gray-green, small, 0.5–3.0 inches (1.3–7.6 cm) long, with underside densely gray haired; twigs densely gray haired.

Dune willow grows on dry sites from Maine to Florida and Minnesota to Oklahoma. In the Albany Pine Bush it occurs with prairie willow, *S. humilis* var. *humilis*, in the pitch pine–scrub oak barrens, where it flowers in late March and early April. Dune willow and prairie willow respond positively to fire by sprouting new stems and increasing in abundance. Rosette or cabbage-like galls, caused by larvae of a gall midge in the genus *Rhabdophaga* (Diptera: Cecidomyiidae) are often found growing on the twigs. In this gall, the stem does not elongate, but leaf growth continues, resulting in deformed bunching of the leaves. It should be possible to locate the gall midge larvae by peeling back the gall leaves. Many birds and mammals eat willow twigs, buds, leaves, and fruit. Caterpillars of viceroy butterflies (*Limenitis archippus* Cramer) consume leaves of *Salix*, *Populus*, and a number of other woody plants.

Of the 11 willows known to occur in the Albany Pine Bush, only 2, *Salix humilis* var. *humilis* and *S. humilis* var. *tristis*, occur in open, sandy situations and have untoothed leaves. Leaves of prairie willow, *S. humilis* var. *humilis*, are longer (1–5 in; 2.5–12.7 cm), wavy edged, and widest beyond the middle. Black willow, *S. nigra*, also occurs in open sands, but it is a large shrub or small tree, and its leaves are fine toothed.

## Leatherleaf

*Chamaedaphne calyculata* (L.) Moench
Ericales: Ericaceae (Heath Family)

A low, evergreen, profusely branched, wetland shrub, to 4 feet (1.2 m) high; leaves 1–2 inches (2.5–5.1 cm) long, leathery, narrow, toothless, somewhat yellow-scaly below; twigs mostly hairless; flowers small, robust, pendant bells, in single, one-sided rows along leafy tips of branches.

Leatherleaf is circumboreal and found throughout Alaska, Canada, the lake states, and the northeastern United States. It tolerates acid conditions and usually occurs where the pH is less than 5. It is usually associated with bog communities, and it is the first shrub to enter a bog community after sphagnum is established. However, it also occurs along edges of swamps and vernal ponds, and in the Albany Pine Bush, it is characteristic of the pine barrens vernal pond community. Leatherleaf is flammable and easily top-killed by fire, but it survives because its rhizomes are deep in saturated soil, and its stems are matted in wet debris. Leatherleaf cannot tolerate shade. It flowers in late April and early May in the Albany Pine Bush. Seeds germinate on sphagnum or sedge mats.

## Black Huckleberry

*Gaylussacia baccata* (Wang.) Koch
Ericales: Ericaceae (Heath Family)

An erect, profusely branched shrub to 4 feet (1.2 m) tall; leaves simple, untoothed, with yellowish resin-dots on both surfaces; flower bell-shaped, greenish white or greenish red, in one-sided clusters; fruit fleshy, black or purple. Huckleberries and blueberries are superficially quite similar. However, huckleberry leaves have tiny, yellow resin dots on both sides, and they have many shiny spots. Blueberries contain many small, fine seeds surrounded by fleshy, palatable pulp, whereas huckleberries contain 10 hard nutlets surrounded by a small amount of pulp.

Black huckleberry is abundant in dry or moist acidic soils in bogs, thickets, and woods from Newfoundland south to Georgia and from Manitoba south to Louisiana. In the Pine Bush, it is abundant in the pitch pine–scrub oak community, and it is a characteristic low shrub in several Pine Bush forest communities. It commonly lines sides of dune trails, where it often intermingles with blueberries. Rhizomes are usually in the humus layer or top 1–2 inches (2.5–5.1 cm) of soil. Stems arise every few inches along the rhizomes to form extensive clones. Colonies extend their range and reproduce after disturbance, such as fire, primarily by sprouting from the rhizomes. Destruction of aboveground stems releases rhizome buds from hormonal suppression and stimulates sprouting. Low-severity fires encourage vegetative reproduction and establishment of vigorous thickets, but severe fires can eliminate black huckleberry from a site. Seedling establishment is rare. Black huckleberry is intermediate in shade tolerance, and after it is established it resists invasion by trees. Flowers appear in late April and May in the Albany Pine Bush. The fruits, which mature in July and August, are eaten by grouse, turkey, and other birds. The shrubs can be used for erosion control on sterile, acidic sites.

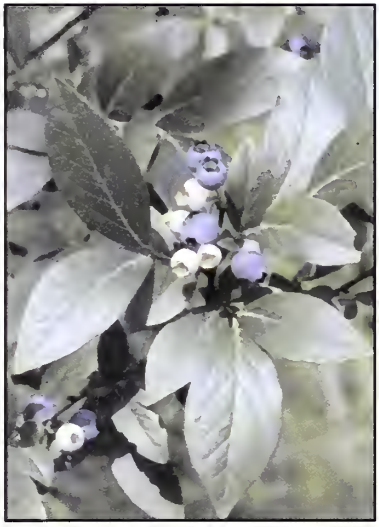
## Sheep Laurel

*Kalmia angustifolia* L.
Ericales: Ericaceae (Heath Family)

A low, evergreen shrub, to 3 feet (0.9 m) tall; leaves leathery, flat, opposite or in whorls of three, untoothed, narrow, elliptical, older ones below flower clusters drooping, new ones above flowers erect; flowers small, to 0.5 inch (1.3 cm) across, in five parts, deep pink, cuplike, seemingly held open by the 10 stamens, in dense, stalked clusters along sides of twigs.

Sheep laurel grows in a variety of sites, ranging from wet sphagnum bogs to dry pine forests, from Newfoundland and Labrador south intermittently as far as Georgia and from Ontario through Michigan to Tennessee. It is most common in the eastern Great Lakes region, the St. Lawrence River region, northern New England, and the Maritime Provinces. It is usually found in association with lowland forests and peatlands in areas that are very dry during the summer but saturated in spring. It is common among pines in the New Jersey Pine Barrens, but fairly uncommon in the Albany Pine Bush.

Sheep laurel is somewhat intolerant of shade, but it persists without appreciable growth under low-light conditions. It is able to out-compete conifer seedlings for nutrients, light, and space, and it produces allelopathic chemicals that retard conifer seedling establishment. Sheep laurel plants are clonal and expand laterally, forming an interlacing network of rhizomes. Sprouts grow from dormant buds on the rhizomes. Rhizomes survive low-intensity fires and sprout soon after fire kills the upper portion of the plant. Sheep laurel flowers in late May in the Albany Pine Bush. The foliage is poisonous to livestock, including sheep, cattle, goats, and horses, especially in winter when the persistent leaves show above light snow cover and are the only available forage. The anthers are tucked into pockets near the border of the flower, and they spring out suddenly when the center of the flower is touched. This peculiar action forces nectar-seeking insects to carry sheep laurel pollen.



## Highbush Blueberry

*Vaccinium corymbosum* L.

Ericales: Ericaceae (Heath Family)

A crown-forming deciduous shrub with two to five stems arising from a single bole, 6–10 feet (1.8–3.0 m) high; leaves pointed, elliptical, toothed or not, smooth and green above, paler and slightly hairy below; flowers small, robust bell-shaped, white or pink; berries blue-black, juicy, sweet, 0.3–0.4 inches (8–10 mm) in diameter.

Highbush blueberry grows from southwestern Nova Scotia south to Florida, and from northeastern Illinois and northern Indiana to northeastern Texas and adjacent Oklahoma. It occurs in many kinds of habitats but seldom dominates, except in some open swamps and bogs and on high-elevation balds. It is most often found along edges of swamps and bogs, on sandy margins of lakes, ponds, and streams, and in open areas of moist woods. It grows best in moist, acidic, well-aerated, highly organic soils. Plants can tolerate long periods of flooding. In the Albany Pine Bush, highbush blueberry is commonly seen in the pine barrens vernal pond community and the red maple–hardwood swamp community. It rarely produces rhizomes, and it is intolerant of shade. Fire can create shade-free sites favorable for its growth if seeds are imported in animal droppings. Highbush blueberry reproduces primarily from seed. Flowers bloom in May, and fruits ripen in July and August. Bees are the primary pollinators. The foliage is consumed by caterpillars of the striped hairstreak butterfly (*Satyrium liparops*). The fruits are important summer and early fall food for several species of birds, including wild turkey, ruffed grouse, quail, scarlet tanager, eastern bluebird, eastern towhee, gray catbird, northern mockingbird, brown thrasher, northern cardinals, and the American robin. Red fox, cottontail, white-footed mouse, skunks, and chipmunks also consume blueberries. Native Americans ate highbush blueberry fruit, and today the plant is extensively cultivated as an agricultural crop.

## Hillside Blueberry, Low Blueberry

*Vaccinium pallidum* Ait.

Ericales: Ericaceae (Heath Family)

A low, usually hairless, shrub, 0.5–2.6 feet (0.2–0.8 m) tall; leaves egg-shaped to elliptical, often widest beyond middle, dull above and below, hairless, untoothed or sparsely toothed, often leathery with age, turning red in fall (lower right photograph); twigs pale, usually hairless; flowers bell-shaped, greenish and white, often tinged with pink or red in sun (upper left photograph); berry dry, blue. Lowbush blueberry shrubs with leaves that are dull pale green on the underside and twigs that are light green or yellowish are hillside blueberry.

Hillside blueberry grows in dry, sunny locations, including thin oak woods, sandy knolls, and roadsides, from Maine to upland Georgia and from southern Ontario and Minnesota to Oklahoma and Arkansas. This and other members of the heath family require sandy, acidic, nutrient-poor soils and moderate light levels. They form associations with fungi that assist them in obtaining nutrients in the poor soils. In the Albany Pine Bush, hillside blueberry grows in abundance in the pitch pine–scrub oak barrens, and along roads and paths. It can also be found in the pitch pine–oak forest and successional northern and southern hardwood forests. Plants spread by means of rhizomes and can form extensive colonies. Hillside blueberry is drought resistant and well adapted to fire, often assuming community dominance under a regime of frequent fires. Buds are resistant to heat damage. Plants sprout readily from rhizomes, root crowns, and surviving portions of aerial stems after aboveground vegetation is burned. Clones persist for many years on undisturbed sites, but fruit production and overall vigor decline with age. In the Albany Pine Bush, hillside blueberry flowers in May. The berries, which are small, bland, and dry to taste, ripen over a fairly long period of time in July and August. They are eaten by many species of birds and mammals, including turkey, eastern towhee, eastern bluebird, chipmunks, and foxes.

The three species of blueberries (*Vaccinium pallidum, V. angustifolium*, and *V. corymbosum*) known from the Albany Pine Bush can be confused with deerberry (*V. stamineum*), black huckleberry (*Gaylussacia baccata*), and maleberry (*Lyonia ligustrina*). In the latter three species, the young twigs are smooth. Young twigs of blueberries are covered with tiny, wart-like elevations. The leaves of hillside blueberry are stouter and more robust than those of black huckleberry, and they turn brighter shades of red in the fall (lower right photograph), making them easy to recognize in the areas where the two species intermingle. Highbush blueberry, *V. corymbosum*, is a tall (> 1 m), crown-forming, wetland shrub. Low sweet blueberry (*V. angustifolium*, the lowbush blueberry of commerce) and hillside blueberry (*V. pallidum*) are low, diffuse, colonial, upland shrubs. Twigs of low sweet blueberry are green and pubescent with incurved hairs in two lines. Leaves are 0.4–1.4 inches (1.0–3.6 cm) long, bright green and usually shiny on the lower surface, and they have prominent veins, a tapered and pointed tip, and serrate margins. The berries are sweet and juicy. Hillside blueberry is often misidentified as low sweet blueberry, especially when it has serrate leaves. Its leaves are 0.8–2.0 inches (2.0–5.1 cm) long, dull green to glaucous (appearing whitish and powdery) on the lower surface, and the veins are not prominent. Twigs are pale green and glaucous, yellowish, or sometimes reddish in the sun, and they can be either smooth or pubescent. The berries are often bland and dry to the taste. Hillside blueberry hybridizes with many species of *Vaccinium*, including low sweet blueberry (Uttal 1987).

Larvae of the rare Pine Bush noctuid moth *Apharetra dentata* are believed to feed on blueberries (Schneider et al. 1991). The rare Pine Bush butterfly Henry's elfin (*Incisalia henrici*) feeds on blueberry and huckleberry in the Pine Bush.

## Black Chokeberry

*Aronia melanocarpa* (Michx.) Ell.
Rosales: Rosaceae (Rose Family)

A native, spreading shrub, 2–5 feet (0.6–1.5 m) tall, with slender branching stems; leaves dark green, glossy above, smooth below, simple, alternate, 2.0–2.5 inches (5.1–6.4 cm) long, often widest toward tip, midrib with tiny raised glands visible with a hand lens; leaf margin with fine, dull teeth; leaves turning orange and purple in autumn, flowers 0.5 inch (1.3 cm) across, white, with five petals, borne in small clusters; fruit 0.3–0.5 inch (8–13 mm) across, nearly black, enclosing two to four seeds.

Black chokeberry occurs in wet or dry thickets from southeastern Canada to South Carolina and from Minnesota to Tennessee. Flowers bloom in May and early June in the Pine Bush. Fruits, which ripen in July and August, are rather bitter, but they are eaten by a number of bird species, and they can be crushed to produce juice for human consumption. Black chokeberry was widely planted in Eastern Europe and the former Soviet Union as an ornamental, and cultivars have been developed for fruit production. Its ease of cultivation, adaptability, clusters of white flowers, lustrous green summer foliage, colorful fruit and fall foliage contribute to its growing popularity as an ornamental in the United States.

Red chokeberry (*A. arbutifolia*) and purple chokeberry (*A.* × *prunifolia*), a hybrid of red and black, also occur in the Albany Pine Bush. Red chokeberry has red fruits and leaves that are downy below. Purple chokeberry is also somewhat hairy and has purple or purple-black fruit.

## Sand-cherry, Eastern Dwarf Cherry

*Prunus pumila* var. *susquehanae* (Hort. ex Willd.) Jaeger
Rosales: Rosaceae (Rose Family)

An upright shrub, 1–3 feet (0.3–0.9 m) tall; leaves 1–3 inches (2.5–7.6 cm) long, simple, alternate, margins toothed along upper portion, olive green above, paler below, leathery, widest toward tip; flowers 0.25–0.50 inches (6–13 mm) across, white, with five petals, in small clusters; fruit nearly round, 0.5 inch (13 mm) long, reddish black.

Three varieties of sand-cherry are recognized in New York State. *Prunus pumila* var. *pumila* is largely restricted to the shores of the Great Lakes and critically imperiled throughout its range. There is compelling evidence that excessive selective browsing by large deer populations is the main reason for its decline. *Prunus pumila* var. *depressa* grows on gravelly river and lake shores and scree slopes, and it is also rare in New York State. *Prunus pumila* var. *susquehanae* occurs in acid, sandy, or rocky barrens, including the Albany Pine Bush. Largely on the basis of its minutely pubescent young twigs and distinct ecology, this variety has been recently treated as a distinct species, *Prunus susquehanae*, also called Appalachian dwarf cherry (Catling et al. 1999). It occurs from southwestern Maine and southwestern Quebec west to Manitoba, and south to Illinois and Virginia. The deeply buried rhizomes assure this plant's survival through

even severe fires. Flowers bloom from late April to mid May in the Pine Bush. Fruits, which ripen in late summer, are sour and thin fleshed, but edible. The foliage turns red in autumn. Larvae of the geometrid moth *Eumacaria latiferrugata* feed on sand cherry. The sand cherries were selected and cultivated for fruit production late in the 19th century, and there is currently renewed interest in exploiting them for development of new crops and as breeding stock for improvement of existing cherry crops.

## Meadow-sweet

*Spiraea alba* var. *latifolia* (Ait.) Dippel
Rosales: Rosaceae (Rose Family)

An erect shrub, 4–5 feet (1.2–1.5 m) tall; leaves 2–3 inches (5–8 cm) long, narrow, fine-toothed; twigs slender, wand-like, hairy or somewhat hairy; flowers white or pale pink, in long, slender clusters.

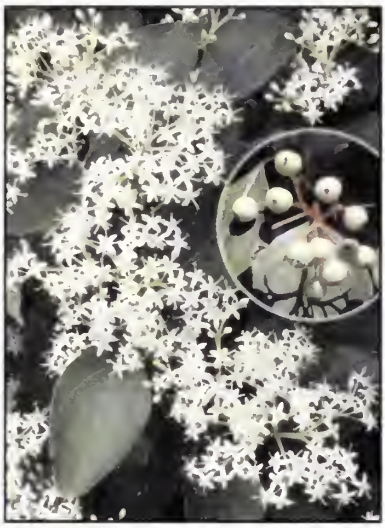
Meadow-sweet occurs in damp meadows from Newfoundland to North Carolina and Saskatchewan to Missouri. In the Albany Pine Bush, it is a predominant shrub in the pine barrens vernal pond community, where it mingles with tussock sedge, spikerush, and bulrush. It can also be found in the pitch pine–scrub oak community and successional northern hardwood communities, and in brushy areas that have been clear-cut. It and other native shrubs have probably displaced rare herbaceous species due to fire suppression and lowering of the water table. Meadow-sweet forms a dense thicket at one site that is presumably a former vernal pond, and it is present to some degree at most vernal pond sites, usually in the drier areas (Mattox 1994). It blooms in July, a little before hardhack flowers appear.

## Hardhack, Steeplebush

*Spiraea tomentosa* L.
Rosales: Rosaceae (Rose Family)

An erect shrub 5 feet (1.5 m) high; leaves 1–3 inches (2.5–7.5 cm) long, coarse-toothed, egg-shaped, with underside woolly; twigs slender, wand-like, woolly; flowers pink, in slender, pointed "steeples."

Hardhack occurs in moist meadows from Prince Edward Island to Georgia and from Manitoba to Arkansas. In the Albany Pine Bush, it occurs in the pine barrens vernal pond community with meadow-sweet, *Spirea latifolia*. It is a conspicuous indicator of habitats that might harbor unusual acid-loving flora. The species flowers in late summer, slightly later than meadowsweet, which has white or pale pink flowers.



## Gray Dogwood

*Cornus foemina racemosa* (Lam.) J. Wilson
Cornales: Cornaceae (Dogwood Family)

A native shrub 4–10 feet (1.2–3.0 m) high with numerous ascending branches forming a dome-shaped thicket; leaves simple, opposite, smooth-margined, 2.5–4.0 inches (6–10 cm) long; flowers small, white, with four petals, in broad, flattish clusters up to 2 inches (5 cm) across; fruit white, round, to 0.5 inch (13 mm) across, in clusters with crimson stems.

This shrub occurs most commonly in the understory of open forests in moderate to full sunlight. It grows from Ontario and the northeastern United States to Kentucky and Oklahoma. In the Albany Pine Bush, gray dogwood occurs abundantly in the pitch pine–scrub oak community. It is also found in the pine–northern hardwood forest, red maple–hardwood swamp, and along paths and forest edges. Flowers bloom in mid June, and fruits ripen in early September. Gray dogwood probably survives fire by sprouting from rhizomes, but soil-stored seeds germinate after fire as well. This plant provides important forage for white-tailed deer, and birds consume the abundant fruits.

Six other species of *Cornus* have been recorded from the Albany Pine Bush. All have untoothed leaves with veins that parallel the leaf edges toward the tip. Bunchberry (*C. canadensis*) is a woodland plant that grows to 8 inches (20 cm) tall. Red osier (*C. sericea*) and silky dogwood (*C. amomum*) are shrubs that grow in wet places. Red osier is distinguished by its white fruit and bright red twigs and branchlets, whereas silky dogwood has bluish fruit and silky, dull purple twigs and branchlets. The remaining species grow in woods, thickets, and along hedgerows. Flowering dogwood (*C. florida*) is a small woodland tree with red fruits. Green osier (*C. alternifolia*) and round-leaf dogwood (*C. rugosa*) are woodland shrubs or small trees with bluish fruits. Only gray dogwood has white fruits supported by red stems.

## New Jersey Tea

*Ceanothus americanus* L.
Rhamnales: Rhamnaceae (Buckthorn Family)

A low shrub, to 1.5–3.5 feet (0.5–1.1 m) tall, with numerous ascending branches; leaves 2–4 inches (5–10 cm) long, somewhat triangular, fan-veined, sharp-tipped, toothed; flowers white, in dense heads; dry capsules three-lobed.

New Jersey tea thrives in dry, open woods, plains, and prairie-like areas from Quebec and Maine to Florida and from Manitoba and Minnesota to Texas. Roots have nitrogen-fixing nodules, like those found in many legumes, giving it a competitive edge over other species in colonizing disturbed sites. New Jersey tea is well adapted to fire, and fire exclusion and subsequent woody plant invasion contribute to its decline. In areas with frequent low-intensity fires, it becomes a conspicuous dominant. New Jersey tea reproduces from seed and by sprouting. Fire weakens the seed coats, thereby assisting germination. Plants flower profusely in June and July in the Albany Pine Bush, and the flowers attract a vast array of

insect species. Leaves of New Jersey tea are the food source for caterpillars of the mottled dusky wing skipper, *Erynnis martialis*, and the geometrid moth *Apodrepanulatrix liberaria*. Deer browse the foliage throughout the growing season. Wild turkeys and some other birds eat the dry capsules. Dried leaves are said to make an excellent tea that was popular around the time of the American Revolution. New Jersey tea is well suited for use in rehabilitation of disturbed sites because of its rapid growth rate and ability to improve soil fertility through nitrogen fixation.

## Smooth Sumac

*Rhus glabra* L.

Sapindales: Anacardiaceae (Sumac Family)

A narrow, perennial shrub or small tree to 20 feet (6 m) tall, with sparsely branched crown; leaves large, up to 2 feet (0.6 m) long, with 11–31 pairs of toothed leaflets; twigs and leafstalks hairless; flowers small, with five whitish petals, crowded into upright conical clusters; fruits small, one-seeded, red, with short, sticky red hairs, in large, conspicuous, upright conical clusters.

This is the most common sumac, native to all 48 contiguous states, although it is most common east of the Rocky Mountains. It occurs especially in sunny areas on sandy soils along forest edges, in clearings, and in similar areas. In the Albany Pine Bush, it occurs abundantly in the pitch pine–scrub oak community. It also occurs in the pitch pine–oak forest, Appalachian oak–pine forest, and sand mine areas. Smooth sumac blooms in July. Fruits begin to redden by late July, and by the end of August they are fully mature. Underground rhizomes promote rapid vegetative spread and formation of dense thickets. Smooth sumac sprouts vigorously from rhizomes following fire. Seeds germinate when fire exposes soil and creates open spaces in the canopy. Native Americans ate young sprouts and made beverages, dyes, and medicines from the fruits. Fruits and leaves are consumed by many species of birds, insects, and small mammals.

Staghorn sumac, *Rhus hirta*, which has very hairy twigs and leafstalks, also grows in the Pine Bush. Its branches resemble deer antlers "in velvet." Winged sumac, *Rhus copallinum*, has untoothed leaflets, and the midrib between leaflets is bordered by narrow, flat "wings."

## Bush Honeysuckle

*Diervilla lonicera* Mill.

Rubiales: Caprifoliaceae (Honeysuckle Family)

A shrub to 4 feet (1.2 m) tall, branches often running close to the ground; twigs slender with hairy ridges; leaves simple, opposite, finely toothed, dark green above; flowers in small terminal clusters, 0.8 inch (2 cm) long, yellow, tubular, with five spreading petal tips; fruit a dry, woody capsule.

Bush honeysuckle is found on well-drained or even dry soils among openings in the woods. It occurs from Newfoundland south to Delaware, and from Saskatchewan south to Iowa. It also occurs in the mountains farther south. Plants are relatively insensitive to light intensity. In the Albany Pine Bush, they are commonly found along trail edges in disturbed barrens and disturbed pitch pine–oak forest. They are also found in the understory of other forest types. Bush honeysuckle reproduces from rhizomes, forming widely scattered patches. Regeneration after fire is rapid, with sprouts appearing from dormant buds on the protected underground rhizomes. A recent Canadian study (Whittle et al. 1997) found that buried seeds will sprout from burned plots but not from clear-cut plots, suggesting that some factor other than increased light, reduced competition, and higher postfire soil temperature stimulates germination. The insect-pollinated flowers appear in June in the Albany Pine Bush. Bush honeysuckle is a preferred browse of white-tailed deer in late summer.

A related species, wild honeysuckle (*Lonicera dioica*) was once common in the Albany Pine Bush. Caterpillars of a noctuid moth, *Homohadena badistriga*, preferred to feed on its foliage, but a certain predatory stink bug provided the plant with a measure of protection from the ravages of the caterpillars. In fact, live caterpillars were found only on bug-free plants. Unfortunately whitetail deer also relish wild honeysuckle. Today it seems that the plant has disappeared from the Pine Bush, and *H. badistriga* was last seen about 1988 (T. L. McCabe, personal communication).

## Pennsylvania Sedge

*Carex pensylvanica* Lam.

Cyperales: Cyperaceae (Sedge Family)

A native, low-growing, grass-like, rhizomatous plant, less than 1 foot (0.3 m) tall, growing in tufts; leaves 4–18 inches (10–46 cm) long, narrow, ascending; tufts with reddish bases; flowering stems slender, erect, sharply rough-angled, with a 0.4–1.0 inch (1.0–2.5 cm) single, terminal, staminate flower spike immediately above one to four smaller, ovoid, sessile, pistillate spikes; rhizomes cordlike and variable in length.

Pennsylvania sedge, also known as yellow sedge, occurs from southern Ontario and Quebec south to Tennessee and Virginia, and from North Dakota southeast to Missouri. This relatively shade-tolerant species is found in both open meadows and in forest understories. In the Albany Pine Bush, it is a component of the pitch pine–scrub oak community, the pitch pine–oak forest community, pine–northern hardwood forest community, Appalachian oak–pine forest community, and successional northern and successional southern hardwood communities. It also occurs along unpaved roads and paths, in sand mines, and in brushy, cleared areas. Pennsylvania sedge regenerates primarily by vegetative means. Long rhizomes allow it to spread into nearby open areas. Short rhizomes are responsible for tuft formation. Seedlings are rare. This cool-season sedge flowers from late April to early May and completes its life cycle before the onset of summer drought.

## Tussock Sedge, Hummock Sedge

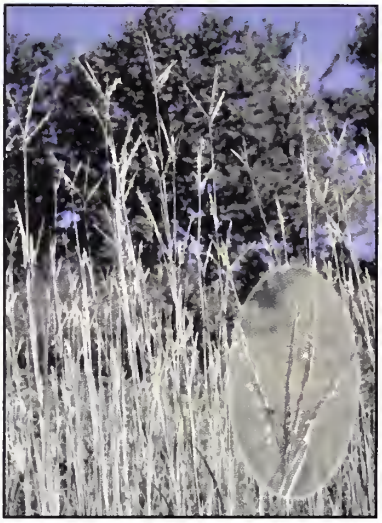
*Carex stricta* Lam.

Cyperales: Cyperaceae (Sedge Family)

A rhizomatous sedge about 3 feet (0.9 m) tall, growing in dense and broad stools or tussocks; leaves rough-margined, long and narrow, about 2.5 feet (0.8 m) long and 0.25 inch (6 mm) wide; stems rough, three-angled, concave-sided, overtopping the rough-margined leaves, ending with three to five narrow, erect 1–2 inch (2.5–5.1 cm) spikes of flowers, with deep brown, green-veined scales; rhizomes wire-like. Tussock sedge is a common species, and its tufts of long, gracefully spreading leaves are well known to those who visit wetlands. The hummocks are used as stepping stones by anyone crossing the wet areas in which they grow.

This calciphilic wetland sedge occurs from Newfoundland south to the Carolinas and Tennessee and from Manitoba south to eastern Oklahoma and Texas. It occurs in both wet meadows and moist forest communities. In the Albany Pine Bush, tussock sedge is abundant in the pine barrens vernal pond and shallow emergent marsh communities, and it is a component of the red maple–hardwood

swamp community. Persistent remnants of these hummocks scattered between dune ridges are indicators of former wetland areas. Tussock sedge is shade intolerant. Sedge communities succeed emergent marsh communities of reeds and cattails in areas where the water is above the soil. A shrub community of willows, dogwoods, and alders follows the sedge community as drier conditions prevail. Fire is important in the maintenance of sedge meadow communities, preventing the encroachment of shrubs and trees. Wet soil protects the roots and rhizomes from fire damage. Tussock sedge flowers in June in the Albany Pine Bush, and fruits ripen in August. However, the sedge reproduces primarily through rhizomes. Long rhizomes produce distant plants; short rhizomes produce stems just offset from the parent plant. Tussock sedge is the larval host plant for the eyed brown butterfly (*Satyrodes eurydice* Johansson), the mulberry wing skipper (*Poanes massasoit* Scudder), and perhaps other marsh skippers.



## Big Bluestem

*Andropogon gerardii* Vitman

Cyperales: Poaceae (Grass Family)

An erect, perennial grass, about 6–9 feet (1.8–2.7 m) tall; leaves 0.2–0.4 inches (5–10 mm) wide, lower ones, along with the sheaths, sometimes with long, soft hairs; stems round, usually hairy, with reddish tint at base; inflorescence with two to six (usually three) fingerlike branches, each 2–4 inches (5–10 cm) long, at end of stem, resembling a turkey's foot; rhizomes coarse, branched, to 10 inches (25 cm) long; main roots extending downward to 10 feet (3 m). Distinguished from other native grasses by long white hairs on upper leaf surface near base of blade and the turkey-foot pattern of inflorescence, which appears in late summer. Sometimes called beardgrass, turkey claw, or turkey-foot grass.

Big bluestem ranges from Quebec and Maine to Florida, and from Saskatchewan and Montana south to Arizona and northern Mexico. Like Indian grass, it is a major component of the tall-grass vegetation that once dominated the prairie states of the Mississippi Valley—the area now known as the Corn Belt. Farther west, it occurs in moist lowland areas of the mixed-grass prairie. Most of the species' natural acreage has been plowed under, but it still grows naturally in open places along roadsides and shores and in fields and prairies in the Midwest and East. Soil moisture is the most important factor determining its dominance in a community. Big bluestem is best adapted to deep, moist, fertile soils, especially calcareous soils, but it also grows abundantly on thin and poor soils if moisture is not limiting. It is not particularly abundant in the Albany Pine Bush, which it perhaps invaded from the midwestern prairies during a warm postglacial interval. It occurs in the pitch pine–scrub oak community, often in low-lying grassy areas between sand dunes. It also occurs along unpaved roads and paths. Although big bluestem is usually a sod-forming species, it tends to form tufts or bunches in drier areas, like the Pine Bush. Big bluestem is well adapted to fire. It initiates new growth from rhizomes after aboveground foliage has been destroyed. It is a warm-season grass, growing rapidly from late spring until late summer, well after cool-season grasses. In spring, dormant plants have carbohydrate reserves stored in underground tissues. Plants quickly send up new growth if burned. In general, late-spring burning best stimulates growth and competitive vigor. It eliminates dead material that keeps the soil cool and shades new growth, and the late timing helps maintain soil moisture until plants are ready to begin their seasonal growth. During the summer growing period, burned plants survive by sending up new growth from rhizomes, but regrowth is slower and less vigorous. Flower stalks are produced in mid to late summer. In the Pine Bush, big bluestem flowers in August and September. Late in the season, the whole plant turns shades of red, brown, and purple. Big bluestem is both palatable and nutritious, espe-

cially in spring and summer when high temperatures retard the growth of cool-season grass species. Livestock and wildlife species often prefer it over other grasses (Brown 1979; Hitchcock 1950; Kucera 1998; Leithead et al. 1971).

## Little Bluestem

*Schizachyrium scoparium* (Michx.) Nash
Cyperales: Poaceae (Grass Family)

An erect, native, perennial grass, about 2–4 feet (0.6–1.2 m) tall, strongly clump-forming in dry soils; plants blue only when very young; mature plants shades of brown, red, and purple, even through winter; leaf blades about 0.25 inch (6 mm) wide; stems stiff, solid, rough, each bearing several slender racemes (stems lined with pedicelled flowers); inflorescence fringed with white, silvery hairs at maturity. Late in the season, the fluffy, white hairs of the grouped stems in a clump resemble a gray beard, and, hence, this species is sometimes called broom beardgrass, prairie beardgrass, or small feathergrass. It is also known as broomsedge, perennial bunchgrass, or wiregrass.

This striking grass occurs in poor or impoverished soils among sand dunes or in prairies, open woods, fields, and on dry uplands from Canada to Mexico. It is absent in the United States only from Nevada and the Pacific coastal states. It is most abundant in the prairie and plains grasslands ecosystems, and it was once the most important species in the American mixed-grass prairie region of North and South Dakota, Nebraska, western Kansas, and other Wheat Belt states. Little bluestem is more tolerant of low soil moisture than is big bluestem. It exhibits both bunch- and sod-forming habits, but it is strongly bunch forming in the dry soils of the Pine Bush. Its presence is regarded as a sign of poor-quality land. Little bluestem can withstand prolonged dry periods, and it replaces the other prairie grasses in drier Pine Bush sites. In the Pine Bush, little bluestem occurs abundantly in the pitch pine–scrub oak community. It is a component of the pitch pine–oak forest community and the successional southern hardwood community, and it also occurs along unpaved roads and paths, in sand mines, and on brushy, cleared land. Little bluestem begins growth in late spring, a little before big bluestem, but after cool-season grasses have already developed. Using stored carbohydrates, new shoots develop from underground buds. Plants subjected to fire when dormant are minimally affected. Fires during the active growing season consume apical meristems, which are about an inch above the soil surface. Fires during dry summer periods are most damaging because the protective plant crown, which would not burn easily if damp, is now easily destroyed. Plants burned when dormant start growth earlier in the spring and are more productive than unburned plants. This earlier and increased growth is attributed to increased solar radiation. Fire removes standing dead plant material and increases solar radiation reaching the soil. Because of the increased solar radiation, soil temperatures on burned areas are higher than in unburned areas. Increased soil temperatures promote earlier root growth and activity, and thus earlier emergence of plant shoots. However, if an area is burned too early in the season, lower production may result due to increased loss of soil moisture from the bare ground before resumption of spring growth. If an area is burned too late, plants that have already started to grow will be set back. Because of spring growth, stored carbohydrates will be diminished, and recovery time will be longer. Little bluestem flowers in late summer, and seeds ripen in October and November. When young, the grass is a valuable forage plant, but deer and other wildlife avoid it as the season progresses. Songbirds commonly consume seeds. Little bluestem is the preferred host plant for caterpillars of the dusted skipper (*Atrytonopsis hianna* Scudder), the cobweb skipper (*Hesperia metea* Scudder), and perhaps other pine barrens skippers.

## Indian Grass

*Sorghastrum nutans* (L.) Nash ex Small
Cyperales: Poaceae (Grass Family)

A tall, clump-forming grass, about 3–7 feet (0.9–2.1 m) high; leaf blades rough to touch, wide, narrowing at point of attachment; ligules usually extending less than 0.13 inch (3 mm) upward and forming a claw-like or "rifle-sight" projection; flowers with conspicuous bright yellow anthers; seed heads single, narrow, plume-like, shining golden brown, 6–12 inches (15–30 cm) long, on stems 4–8 feet (1.2–2.4 m) tall; root system extensive, tough; rhizomes short. Distinguished from other native grass species by the "rifle-sight" ligule at the point where the leaf attaches to the stem

This striking native perennial grass is found from Quebec and Maine south to Florida, and from central Saskatchewan south to Arizona and northern Mexico. It is one of the dominant species of the tall-grass prairie of the present-day Corn Belt, though not as prevalent as big bluestem. In the East it occurs sporadically along dry roadsides and in old fields and open woods, often along with big bluestem. Indian grass grows in prairies, bottomlands, open woods, and meadows. It is best adapted to deep, moist soils, including deep sands and heavy clays, and it tolerates brief or periodic flooding. It readily invades disturbed areas with bare soil. In the Albany Pine Bush, Indian grass occurs abundantly in the pitch pine–scrub oak community. It survives fire by sprouting from rhizomes. Density and vigor increase with late spring burning prior to green-up. After long periods without fire, Indian grass is replaced by big bluestem and woody vegetation. Indian grass is moderately shade tolerant, and it is often found in brushy thickets where herbivores are unable to graze it. Indian grass is a warm-season species. Most of its production occurs while cool-season grasses are dormant. It starts growing in midspring from short rhizomes. When it flowers during late August, the bright yellow anthers are conspicuous. Seed heads mature in September and October. In the Midwest, Indian grass provides quality forage for livestock and wildlife when high temperatures retard the growth of cool-season grass species.

## Wild Columbine

*Aquilegia canadensis* L.

Ranunculales: Ranunculaceae

A herbaceous perennial, 1.0–2.5 feet (0.3–0.8 m) tall; stem erect, branching, smooth; leaves divided and subdivided into threes; flowers red and yellow, nodding, with five long upward spurs.

Wild columbine is found on moist, well-drained soils in the partial shade of woods and thickets, often associated with limestone outcroppings and glacial moraine. It occurs from Nova Scotia to Florida in the East and the Northwest Territories to Texas farther west. Its sparsely branched stems and thin, deeply cut foliage give it a light and airy appearance. It is scattered and not particularly common in the Albany Pine Bush. It flowers in May and June, and the flowers are pollinated by hummingbirds. Aboveground portions of the plant die back in mid to late autumn. Reproduction takes place from seed, and plants can survive fire and other disturbances by resprouting from the base of the stem (caudex). Native Americans used the plant as a remedy for various ailments, especially gastrointestinal problems (Duke 1986). Wild columbine is the food plant for caterpillars of the columbine dusky wing skipper, *Erynnis lucilius*, which has not been found in the Albany Pine Bush in many years.

## Rue Anemone

*Thalictrum thalictroides* (L.) Eames & Boivin

Ranunculales: Ranunculaceae (Crowfoot Family)

A low, delicate, smooth perennial, 4–8 inches (10–20 cm) tall; stems slender, weak; leaves compound, leaflets somewhat round, three-lobed at end, long-stemmed; flowers 0.5–1.0 inches (1.3–2.5 cm) across, with 5–10 white, petal-like sepals; flower stem with two to five flowers above whorl of small, three-lobed leaves.

Rue anemone grows in open woodlands from Maine to Florida and from Minnesota to Oklahoma. In May and June its delicate white flowers are conspicuous along Albany Pine Bush woodland paths. The lobed leaves are distinctive. The basal leaves, arising from a cluster of tuberous roots, appear later in the season, after the flower stalks. This species is easily cultivated.

## Winged Pigweed

*Cycloloma atriplicifolium* (Spreng.) Coult.
Caryophyllales: Chenopodiaceae (Goosefoot Family)

An erect or speading annual herb, 6–18 inches (15–46 cm) tall, densely branched; leaves alternate, coarsely toothed, petioled, often falling early; flowers very small, scattered, sessile, stamens and pistil in same flower, or pistil in separate flower; fruiting calyx winged.

This densely branched, coarse weed often forms rounded, tumbleweed-like mounds, which are common in the Midwest. It occurs naturally from Indiana and Manitoba south to Arkansas, Texas, Arizona, and northern Mexico. It might have arrived in the Northeast from its native central North American range on circus wagons (Boyle 1969). Winged pigweed typically grows in sandy fields and blowouts, on beaches, and along stream banks. Small, greenish flowers, which appear in July and August, produce small, single-seeded fruits surrounded by a flat, circular, nearly transparent wing less than half a centimeter across. The leaves may fall early, before the fruits mature. Plants turn red to purple in autumn.

## Frostweed

*Helianthemum canadense* (L.) Michx.
Violales: Cistaceae (Rockrose Family)

A perennial herbaceous plant, 8–18 inches (20–46 cm) tall; leaves 1 inch (2.5 cm) long, narrow, hairy underneath, alternating along stem; showy flowers about 1 inch (2.5 cm) across, solitary, at ends of stems, yellow, resembling single roses; budlike cleistogamous flowers in leaf axils.

Frostweed grows in dry, sandy openings from Nova Scotia to North Carolina, and from southern Ontario and Wisconsin south to Missouri and Mississippi. In the Pine Bush, the yellow flowers at the ends of stems, which bloom for only a day, appear in June and July. They are followed by small, budlike flowers in leaf axils and on developing branches. Late in autumn, thin, curved crystals of ice shoot from fissures in the bark at the base of the stem.

Three other members of the rockrose family were at one time reported from the Pine Bush, but they have not been found in recent surveys. They are the pine-barren frostweed (*Helianthemum bicknellii*) and two pinweeds (*Lechea intermedia, L. mucronata*).

*Courtesy Margaret M. Stewart*

## Bird's-foot Violet

*Viola pedata* L.
Violales: Violaceae

A small herbaceous plant, 4–10 inches (10–25 cm) tall; leaves shaped like bird's feet, deeply divided into three to five or more narrow segments, some of which are subdivided and toothed; flowers blue-violet, lower petal partly white; upper petals flared backward; all petals beardless; orange stamens conspicuously protruding in center.

Bird's-foot violet is a calciphile, growing in dry, open, sandy fields and on shale barrens from Massachusetts, southern Ontario, and Minnesota south. This rather sporadic plant is an example of arid land species that are not fire resistant. Pine barrens forms have all petals the same color, but one variety has bicolored flowers, with paler lower petals. The flowers, which have become a rare sight in the Pine Bush, can be seen in late April and early and mid May. The magnificent regal fritillary butterfly, *Speyeria idalia*, whose caterpillars locally depend on bird's-foot violet, and perhaps lance-leaf violet, for food, is declining throughout its range, and it no longer adorns the Pine Bush. Bird's-foot violet appears on the New York State Protected Native Plant List, meaning that it may not be legally gathered or removed from a plot of land without the permission of the landowner.

## Whorled Loosestrife

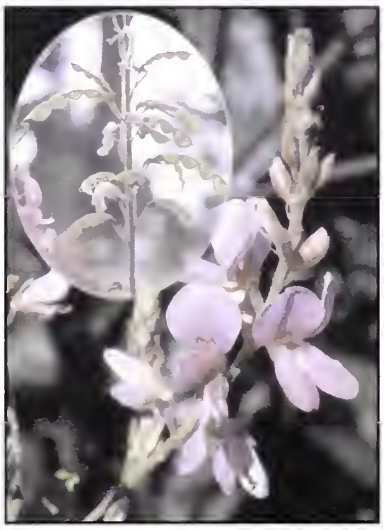
*Lysimachia quadrifolia* L.
Primulales: Primulaceae (Primrose Family)

A herbaceous perennial, 1–3 feet (0.3–0.9 m) tall; leaves 2–4 inches (5–10 cm) long, stemless, arranged in whorls of four; flowers about 0.5 inch (1.3 cm) across, star-like, yellow, marked with red around the center, arising from leaf axils. This distinctive member of the primrose family is easily identified by the whorls of four sessile leaves with yellow flowers arising from the leaf axils.

Whorled loosestrife occurs in dry or moist open woods and thickets from Maine and southern Ontario to Georgia, and from Wisconsin to Alabama. In the Albany Pine Bush it flowers in June. It is very common here, spreading rapidly and widely by creeping rhizomes. Colonists fed the plant to oxen to pacify them and induce them to work together, but it is possible that this practice was merely based on a fanciful interpretation of the whorled leaves and flowers. Larvae of the noctuid moth *Papaipema lysimachiae*, a pine barrens specialist, feed on whorled loosestrife.

Five other species of *Lysimachia* have been found in the Albany Pine Bush in recent surveys. Four-flowered loosestrife, *L. quadriflora*, is an endangered species in New York State. It has very narrow, stiff leaves and slightly toothed flowers. The remaining species occur in wetlands. Moneywort, *L. nummularia*, is an introduced, trailing species with round, paired leaves. It is an invasive groundcover in at least one Pine Bush wetland. Tufted loosestrife, *L. thyrsiflora*, has

flower clusters arising from the axils of the lower leaves. Swamp-candles, *L. terrestris*, has a terminal, spike-like cluster of flowers. Fringed loosestrife, *L. ciliata*, has leaves with fringed stalks arranged in pairs along the stem.



## Giant Tick-clover

*Desmodium canadense* (L.) DC.

Fabales: Fabaceae (Bean Family)

A tall, erect, plant, 2–6 feet (0.6–1.8 m) high; stems somewhat woody; leaves short-stalked, clover-like, with three narrow, oblong leaflets; flowers pink or rose-purple, pea-like, in long, crowded, terminal clusters; fruit a hairy pod with three to five segments.

Giant tick-clover grows in dry to mesic open woods and scrubby thickets from Nova Scotia to Virginia and from southern Saskatchewan to Oklahoma. In the Pine Bush it flowers from July to September. The jointed fruits, known as loments, break into single-seeded segments that stick to clothing and animal fur.

Of the four species of *Desmodium* found in the Pine Bush in recent years, giant tick-clover is the showiest, has the most crowded flower spikes, and has short-stalked leaves with slender leaflets. Hoary tick-clover (*D. canescens*) has finely hairy, often sticky, stems and leaf-stalks. Sticky tick-clover (*D. glutinosum*) has broad, pointed leaves in a whorl, from which the flower stalk arises. Tick-trefoil (*D. nudiflorum*) has leafless flower stalks. Tick-clover (*Desmodium ciliare*) is believed to be extirpated from the Albany Pine Bush (Schneider et al. 1991)

## Round-headed Bush Clover

*Lespedeza capitata* Michx.

Fabales: Fabaceae (Bean Family)

A tall, perennial, herbaceous plant, to 5 feet (1.5 m); leaves nearly stalkless, hairy, with three narrow, oblong leaflets; flowers white with purplish-red spots, in dense, round clusters in axils of upper leaves.

Round-headed bush clover occurs from New England to Minnesota and southward. Its tall, slender, erect stems are conspicuous in the barrens, where it blooms in August in dry, open, sandy areas. The dry, dead stems persist through the winter, when they are especially conspicuous. Bush clover provides food for caterpillars of a number of butterflies and moths, including the eastern tailed blue (*Everes comyntas*), southern cloudy wing (*Thorybes bathyllus*), northern cloudy wing (*T. pylades*), silver-spotted skipper (*Epargyreus clarus*), and the notodontid moth *Dasylophia anguina* (Tietz 1972).

Of the other *Lespedeza* species reported from the Pine Bush, *L. hirta* also has white flowers, but the heads are less dense, and more spikelike and cylindrical; the leaflets are more rounded; and the stem is densely hairy. *L. procumbens* and *L. thunbergii* (not seen in recent years) have purple or violet-purple flowers. All species are adapted to warm, humid climates.

## Wild Lupine

*Lupinus perennis* L.

Fabales: Fabaceae (Bean Family)

A native, cool-season, herbaceous perennial, 8–24 inches (20–61 cm) tall; leaves mostly basal, palmately compound, with 7–11 lanceolate leaflets, each up to 2 inches (5 cm) long, radiating from a central point; inflorescence an erect terminal cluster on the stem; flowers blue, pea-like, up to 0.7 inch (1.8 cm) long; fruit a hairy pod, up to 2 inches (5 cm) long.

Wild lupine, the only native lupine in New York State, occurs along the Gulf of Mexico coast from eastern Texas and Louisiana to Florida, up the Atlantic coast to southern Maine, and westward across New England and New York to the western end of the southern Great Lakes region in Minnesota. It grows only on sandy soils in dry, open woods and fields where competition and shade are reduced by recent burns or other catastrophic events. Its ability to fix nitrogen allows it to colonize disturbed sites and soils of low fertility. Legumes have a temporary advantage on burned sites where fires have been hot enough to volatilize nitrogen and thereby suppress competing vegetation. Wild lupine persists under partial shade, but its cover increases with more sunlight and less competition. It can become established rapidly at sites where the forest canopy is opened, and it has been observed to expand dramatically after burning. Robert Dirig (1994) has observed that wild lupine appears to be a calciphile, favoring alkaline sands. It and other calciphiles are perhaps associated with lime deposited during glacial runoff from the limestone of the nearby Helderberg Mountains.

In the Albany Pine Bush, wild lupine grows in the pitch pine–scrub oak and pitch pine–oak forest communities, along unpaved roads and paths, and in sand mines. It was formerly much more abundant in the Pine Bush than it is now, especially in the area presently occupied by the New York State office building campus and the University at Albany. During the past 15–20 years, numbers and sizes of lupine populations have declined dramatically. It is believed that lupine populations (and consequently Karner blue butterfly populations) are about one-tenth of what they were only 10 years ago. The cause of this decline has not been pinned down, but it probably involves a number of factors, including fire suppression and land development. Many lupines tend to increase under intensive grazing, so it seems that deer, rabbits, and other animals probably are not responsible for the decline.

Although aboveground parts of wild lupine are generally consumed by fire, taproots probably survive even severe fires, and plants resprout from the caudex, a persistent woody basal stem. Lupines most often reproduce by seed. The heavy, poorly dispersed seeds are stored in the soil, and they germinate in mineral soil in full sun or partial shade. Plants top-killed by fire can recover and rapidly increase in vigor, but an increase in plant numbers must await seed production. Fire can break seed dormancy, increase available nutrients, and remove inhibitory compounds in surrounding litter.

This beautiful, spring-blooming (late May–early June) member of the pea family forms perennial clumps, and after seed pods ripen, visible parts of the plants shrivel and disappear until the following spring. Plants are nearly impossible to transplant because of their long, easily damaged tap roots. They also are difficult to propagate from seeds because, if the seeds are not inoculated with nitrogen-fixing *Rhizobium* bacteria, the young plants eventually die. Holly Emmons of the State University of New York at Cobleskill has experimented with propagation techniques so that wild lupines can be cultivated for reintroduction to the Pine Bush (Ginsburg 1998), and she recommends this as a feasible project for horticultural hobbyists.

The effects of the decline of wild lupine are especially evident in the condition of the butterfly fauna that specializes on this food source. The Persius dusky wing skipper, *Erynnis persius*,

was last reported from the Albany Pine Bush in the late 1970s, even though the Pine Bush is well within the range of this species (McCabe 1993). The threatened frosted elfin, *Incisalia irus*, while still present in the Pine Bush, has become quite rare and declines with every loss of lupine habitat. Of course wild lupine is the only food plant of the caterpillar of the endangered Karner blue butterfly, and the plant's recent decline is certainly the reason for the present rarity of the Karner blue. Both species may be of western origin, having evolved into distinct eastern species or subspecies after ancestors reached the East during the warm, postglacial hypsithermal interval. An alternative hypothesis argues that glaciation pushed them southward, and when the last glacier retreated, wild lupines and Karner blues returned via the Atlantic Coastal Plain and a band of sandy barrens habitats stretching from New England across the southern Great Lakes region (Kurczewski 1998). Other species that browse wild lupine include deer, rabbits, and woodchucks.

## Goat's Rue

*Tephrosia virginiana* (L.) Pers.

Fabales: Fabaceae (Bean Family)

A herbaceous legume, 1–2 feet (0.3–0.6 m) tall; leaves pinnately compound, with eight or more pairs of silvery leaflets, 0.5–1.5 inch (1.3–3.8 cm), arranged along a central stem; flowers 0.8 inch (2 cm) long, with pink wings and yellowish white central standard, in clusters at end of a hairy stem; fruit a whitish hairy pod, up to 2 inches (5 cm) long.

This handsome silvery perennial plant is also known as devil's shoestring, hoary pea, or turkey pea. It occurs from New Hampshire to Florida and west to Wisconsin and Texas in droughty glades and savannas of scrub oaks, pines, and prairies, usually on well-drained, sandy soil. In the Albany Pine Bush, it blooms from the middle of June to the middle of July. Its preference for disturbed, open areas can be explained by its ability to mechanically disperse mature seeds through explosive dehiscence of the pods. The seeds germinate over a period of time in acid soil of low moisture content. Experimental evidence indicates that *T. virginiana* increases in aboveground biomass and flowers prolifically following spring burns (Dudley and Lajtha 1993). Older plants, with their extensive root systems and increased shade tolerance, can linger in older stands as representatives of a relic species (Clark 1971). Some Native Americans used the plant as a medicine and fish poison. Plants from relatively small districts in Georgia, Florida, and Texas have insecticidal properties due to the rotenone content of the roots. Apparently roots of New York plants are nontoxic (Seviers et al. 1938). At least one skipper, *Thorybes bathyllus*, the southern cloudy wing, has been reported to feed on *Tephrosia*, and it feeds on a number of other Pine Bush legumes as well.

## Bastard-toadflax

*Comandra umbellata* (L.) Nutt.

Santalales: Santalaceae (Sandalwood Family)

A small herbaceous plant, 6–16 inches (15–41 cm) tall, short-branched on upper third; leaves about 1 inch (2.5 cm) long, alternate, oblong, pale beneath; flowers white, small, 0.17 inch (4 mm) across, cup-like, with five white sepals, no petals, grouped in terminal clusters.

Bastard-toadflax grows in dry fields adjacent to coniferous forests from Maine to Georgia and from the Cascade Mountains to Texas. In the Albany Pine Bush it is commonly seen blooming in late May and early June in pitch pine–scrub oak communities. The rhizomes produce adventitious roots that can, in concert with a fungus, produce button-like structures called haustoria. Each haustorium may fold around the root or rhizome of a host plant and penetrate it to absorb its nutrients. The genus *Comandra* supports part of the life cycle of *Comandra* blister rust, a fungus that attacks pine trees. The rust is most prevalent in the West, where its principal hosts are lodgepole pine and ponderosa pine, but elsewhere host trees include Table Mountain, loblolly, shortleaf, and pitch pines. The incidence of the disease is scattered, however, and its damage is only occasionally of local importance.

## Rose Milkwort

*Polygala sanguinea* L.

Polygales: Polygalaceae (Milkwort Family)

An annual herbaceous plant, 5–15 inches (13–38 cm) tall; stem upright, branched or unbranched; leaves about 1 inch (2.5 cm) long, narrow, alternating along stem; flowers tiny, rose, pink, white or greenish, in dense, clover-like clusters, with bracts beneath flowers persisting on stem when flowers fall; root with wintergreen odor when crushed.

Rose milkwort, also called field milkwort or purple milkwort, grows in sunny fields and meadows with moist acid soils from Nova Scotia and Ontario, south to South Carolina, west to Tennessee and Louisiana, and north to Oklahoma and Minnesota. In the Albany Pine Bush, it flowers from late July through September. A closely related species, *P. nuttallii*, grows in the dry, open soils of Long Island pinelands, where it has the reputation of being almost infallible as a remedy for fever and ague.

Another Pine Bush milkwort, *P. paucifolia*, known as fringed polygala or gaywings, grows in moist, wooded areas of the Pine Bush. It has a short stem, broad, evergreen leaves, and delicate, orchid-like, pink flowers with wings.

## Spreading Dogbane

*Apocynum androsaemifolium* L.

Gentianales: Apocynaceae (Dogbane Family)

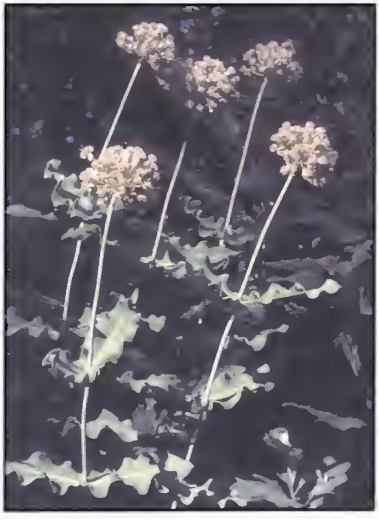
A bushy plant, to 4 feet (1.2 m) tall; stem sturdy, smooth, reddened on sunny side, exuding milky juice when broken; leaves ovate, paired, untoothed; flowers fragrant, small, tubular, bell-like, terminal or in leaf axils, nodding, white with pink stripes inside; seed-pods long, narrow, in pairs.

Spreading dogbane is a widespread species, occurring in dry open fields, thickets, and along borders of dry woods from Newfoundland to the uplands of North Carolina and from Alaska to northern Mexico. It can be found in the pitch pine–scrub oak barrens, pitch pine–oak forest, and Appalachian oak–pine forest of the Albany Pine Bush. During June and July, its white and pink bells are seen dangling from ruddy curved stalks bearing paired, ovate, and often drooping leaves. The deeply buried rhizomes assure this plant's survival through even severe fires. The flowers frequently imprison insects. Like the closely related milkweeds, spreading dogbane exudes a milky juice when stems are broken, and the plant has been considered as an emergency rubber source. Dogbane fiber was once used as a hemp substitute. The plant is extremely poisonous, containing a cardioactive drug. It has been used to treat a number of ailments, including rheumatism, scrofula, and syphilis (Duke 1985).

## Blunt-leaf Milkweed

*Asclepias amplexicaulis* Sm.

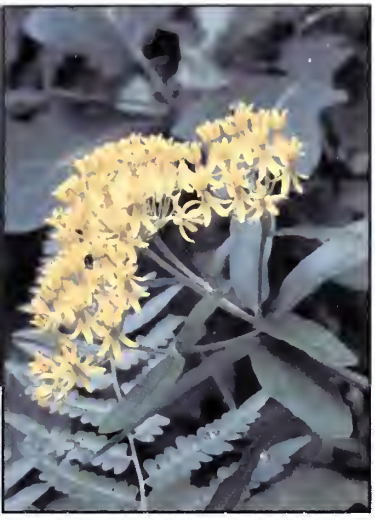
Gentianales: Asclepiadaceae (Milkweed Family)



A tall herbaceous plant, 2–3 feet (0.6–0.9 m) tall; leaves opposite, stalkless, clasping stem, oblong, rounded at both ends, with wavy edges; flowers greenish purple, in domed clusters.

Blunt-leaf milkweed, which is also known as clasping milkweed or sand milkweed, grows in dry, sandy fields and open woods from Massachusetts to Florida, and from Minnesota to Texas. It blooms mid June to mid July in the Albany Pine Bush, where it occurs only sporadically in the pitch pine–scrub oak community. Blunt-leaf milkweed is a food source for caterpillars of the monarch butterfly and some other Lepidoptera.

Five other species of milkweed also are known from the Pine Bush. The spectacular orange-flowered butterfly-weed is described below. The common milkweed (*A. syriaca*), four-leaved milkweed (*A. quadrifolia*), and swamp milkweed (*A. incarnata*) have pink flowers in domed clusters, but common milkweed has broad, opposite leaves, four-leaved milkweed has leaves arranged in whorls of four, and swamp milkweed has narrow leaves. Poke milkweed (*A. exaltata*) has dangling clusters of white flowers tinged with lavender or green.



## Butterfly-weed

*Asclepias tuberosa* L.

Gentianales: Asclepiadaceae (Milkweed Family)

An erect, herbaceous perennial, 1–3 feet (0.3–0.9 m) tall; stems hairy, leafy, lacking milky sap; leaves to 3 inches (8 cm), simple, oblong; flowers bright orange-yellow, 0.25 inch (6 mm) across, in thick, rounded or flat-topped clusters.

Butterfly-weed grows in full sun in sandy, well-drained soils from Maine south to Florida and west to Colorado and Arizona. In the Pine Bush it is often found in association with scrubby oaks along trails and powerline rights-of-way. The striking flowers appear here during the heat of July and August, and they are magnets for butterflies. This showy milkweed is frequently grown from seed in home gardens. The thick, tuberous rootstock acts like an underground cactus, storing water, nutrients and other chemicals and helping the plants survive in hot, dry Pine Bush conditions. Mohegan and other Indians, as well as pioneers, chewed roots as a treatment for bronchial and pulmonary disorders, and the plant is often referred to as pleurisy root (Duke 1986). Butterfly-weed was viewed favorably by many of the early writers on American medicinal plants. However, if eaten in large quantities, the plant is toxic, causing vomiting, stupor, weakness, and spasms. Butterfly-weed is a food source for caterpillars of the monarch butterfly and some other Lepidoptera. It appears on the New York State Protected Native Plant List, meaning that it may not be legally gathered or removed from a plot of land without the permission of the landowner. Its taproot makes it extremely difficult to transplant specimens successfully.

## Wild Bergamot

*Monarda fistulosa* L.

Lamiales: Lamiaceae (Mint Family)

An erect, herbaceous perennial, 1.3–4.0 feet (0.4–1.2 m) tall; stem square in cross section; leaves coarsely toothed, lanceolate, about 1–3 inches (2.5–7.6 cm) long; flower cluster 1.0–1.5 inches (2.5–3.8 cm) across, at top of stem, dense, rounded, ragged, with 20–50 lavender, tubular flowers.

This aromatic member of the mint family is found from Quebec to Georgia in the east and from Minnesota to Texas farther west. It is common in dry fields, thickets, and along woodland edges, especially in calcareous regions. The lilac-colored flowers bloom in July and August, attracting myriads of butterflies, moths, bees, wasps, and hummingbirds. The flowers are considered a good nectar source for bees. This showy perennial, with slender creeping rhizomes, commonly occurs in large clumps. It can be invasive in gardens. Leaves can be used to make a mint tea.

## Dotted Horsemint

*Monarda punctata* L.

Lamiales: Lamiaceae (Mint Family)

A herbaceous perennial, 1–2 feet (0.3–0.6 m) tall; stem square in cross section, simple or branching; leaves opposite, shallow toothed; flowers yellow with purple-brown spots, arranged in rosettes in upper leaf axils, above whorls of white to lavender bracts.

Dotted horsemint occurs mostly on dry, sandy soils in open areas along the coastal plain from New England to Florida and west to Louisiana and Wisconsin. It blooms in July and August in the Albany Pine Bush, providing nectar and pollen for myriads of insects. *M. punctata* has the highest thymol content of all the mints. Its sharp and pungent aroma fills the midsummer air. Historically extracts from the plant were used for a number of medicinal purposes. Striking yellow and lavender inflorescences and distinctive aroma make dotted horsemint an interesting ornamental plant for sandy soils.

## Pearly Everlasting

*Anaphalis margaritacea* (L.) Benth. & Hooker f. ex Clarke

Asterales: Asteraceae (Aster Family)

An erect herbaceous perennial, 1–3 feet (0.3–0.9 m) tall; stem unbranched, white, woolly; leaves alternating along stem, elongate, gray-green above, white and wooly beneath, rolling under at edges; flower heads 0.25 inches (6 mm) across, globular, in tight, flat-topped clusters; ray florets lacking; dry papery bracts crowding around yellow disc.

Pearly everlasting is a variable species occurring in dry, gravelly, and sandy soils, pastures, clearings, thickets, and shores, and ascending to subalpine areas over most of North America from Newfoundland south to Virginia and from southern Alaska south to California. It blooms July to September in the Albany Pine Bush. It is a weedy colonizing species, able to invade by long-distance dispersal and often seeding in after fire. Studies have shown it to be one of the most common herbaceous plants on recent landslides in the Cascade Mountains (Miles and Swanson 1986) and on the devastated Pumice Plains of Mount St. Helens after the 1980 eruptions (Wood and del Morel 1988). The showy, white flowers, which retain their color and texture when dried, are often used in dried flower arrangements. This attractive native plant is easily propagated as a garden flower. Mohawk Indians drank a flower infusion with mullein roots as a treatment for asthma. Pearly everlasting has also been used as a herbal remedy for a number of other ailments (Duke 1985, 1986).

## Late Purple Aster

*Aster patens* Ait.

Asterales: Asteraceae (Aster Family)

A herbaceous perennial, 1–3 feet (0.3–0.9 m) tall, stems slender, rough-hairy, widely branched, arising in cluster from persistent caudices; rhizomes usually lacking; leaves oblong-oval, toothless, stalkless, alternating along, and clasping, stem, with rough edges and upper surface; flower heads purple.

Late purple aster occurs in dry, upland, acidic, open woodland, especially oak-pine and oak-hickory, from Vermont to Florida and Minnesota to Texas, although it is considered primarily a southern species (Jones 1983, 1992). It has been divided into three geographic varieties, with only the variety *patens* common east of the Mississippi River. Plants are most common in the full sun or partial shade of woodland borders, along paths, under powerlines, and in other disturbed areas. Late purple aster overwinters as rosettes, bolting in the spring. Flowering occurs in the fall, with pollination assisted by bees, butterflies, moths, and beetles. In the Albany Pine Bush, this species starts to bloom in late August and peaks in early October.

Asters, like goldenrods, comprise a large group of similar species in the family Asteraceae, formerly known as the Compositae. The compound flower heads, which are often thought of as individual flowers by nonbotanists, are composed of central, tubular florets, or disc flowers, which are usually yellow, and outer ray flowers that range in color from white to pink to blue or purple. In recent surveys, 14 species of *Aster* have been recorded from the Albany Pine Bush. Many of them can be difficult to identify accurately. Six species have white ray flowers or "petals." The other 8 species have pink to purple rays. The blue wood aster, *A. cordifolius*, has heart-shaped, stalked leaves. The stiff-leaf aster, *A. linariifolius*, has rigid, needle-like leaves. The remaining 6 species have leaves that clasp the stem. *A. patens* is distinguished by its relatively short, oblong-oval, stalkless and toothless leaves that nearly encircle the hairy stem and by flower heads that have only 15–25 purple rays and a bright yellow central disc. The very similar New England aster, *A. novae-angliae*, has lanceolate leaves crowded along the stem and flower heads with 40 or more rays. Purple-stemmed aster, *A. puniceus*, has bristly purplish stems and, usually, toothed leaves. *A. patens* is sometimes misidentified as *A. undulatus*, a species with basal, heart-shaped leaves on winged leafstalks, and clasping upper leaves.

## Spotted Knapweed, Bushy Knapweed

*Centaurea maculosa* Lam.

Asterales: Asteraceae (Aster Family)

A tall, noncreeping, herbaceous perennial, to 4 feet (1.2 m); one to six stems per plant, wiry, highly branched, bushy; rosette leaves to 6 inches (15 cm) long, stem leaves shorter, highly dissected; flower heads solitary at shoot tips, thistle-like, purple to pink and rarely white, to 1 inch (2.5 cm) across, with prickly, black-tipped bracts giving head a spotted appearance.

Also called bushy knapweed, *Centaurea maculosa* is an aggressive, invasive, and noxious weed from Eurasia, where it is found in light, porous, fertile, well-drained, and often calcareous soils in warm areas. It was introduced into North America late in the 19th century and has spread across southern Canada south to South Carolina and west to California. In the Pine Bush, thick stands occur in many open, sandy areas, and the plant is common along trails and in other disturbed areas. Plants on average live for 3–5 years. The flowers, which appear in the Pine Bush in July and August, are an important nectar source for a number of Pine Bush insects, including honeybees and the spectacular hummingbird clearwing moths, which are often seen hovering at flowers during daytime. Spotted knapweed reproduces from seed and forms a new shoot each year from the taproot. Seeds are dispersed by wind, can remain dormant in soil for several years, and germinate in spring or fall.

Spotted knapweed is most common in disturbed areas where the natural environment has been changed drastically making is easy to gain a foothold and take over. Once it is established, it maintains a foothold and spreads through high seed production. It continues to spread into surrounding, undisturbed native communities, displacing indigenous species. Its taproot takes up water and nutrients faster than the root systems of its neighbors. Glandular trichomes covering the epidermal surfaces of aerial tissues produce cnicin, a biologically active substance that makes the plant bitter and unpalatable. Cnicin leached from knapweed leaves may also inhibit germination and root growth of other, more desirable species. Soil erosion is another problem associated with knapweed. Knapweed's taproot cannot bind the soil together the way the fibrous root systems of many native plants can.

Low-intensity fire does not control spotted knapweed. Instead, such disturbance could promote its colonization. Persistent hand pulling can reduce populations, but there is some suggestion that *Centaurea* species contain carcinogenic properties, or might be a trigger to activate cancerous cells in the human body, so personal protection and washing are highly recommended for anyone who engages in this activity (Sheley et al. 1998).

## Woodland Sunflower

*Helianthus divaricatus* L.

Asterales: Asteraceae (Aster Family)

A tall perennial herb, 2–5 feet (0.6–1.5 m) high; stem smooth; leaves paired and opposite each other along stem, stiff, rough above, hairy below, nearly stalkless, tapering to tip, not tapering at base; flower heads more than 2 inches (5 cm) across, with 8–20 bright yellow rays ("petals").

Woodland sunflower can be found in dry woods and clearings from Maine to Florida in the East and Manitoba to Louisiana farther west. After it begins blooming in July, this common Pine Bush sunflower is conspicuous until October along woodland edges. It is a food plant of the caterpillar of the silvery checkerspot butterfly, *Chlosyne nycteis*.

Three other sunflowers have been found in recent surveys in the Pine Bush. Wood-sunflower, *Helianthus strumosus*, like woodland sunflower, has leaves paired and opposite each other along the smooth stem. However, the largest leaves of *H. strumosus* have slender-based stalks (petioles) that are more than 0.4 inch (1 cm) long, whereas those of *H. divaricatus* have stalks less than 0.2 inch (5 mm) long or absent (leaves sessile). Common sunflower, *H. annuus*, and Jerusalem artichoke, *H. tuberosus*, which are not native to the Pine Bush but have spread through cultivation, have leaves alternating along the stem. Common sunflower, from the midwestern prairies, is a miniature of the domesticated form, with heart- or spade-shaped leaves, a rough, hairy stem, and large flower heads, 3–6 inches (7.6–15.2 cm) across. Jerusalem artichoke is a tall plant, 5–10 feet (1.5–3.0 m) high, that grows in moist soils. It has large flower heads and thick, rough, toothed leaves with winged stalks.

## Early Goldenrod

*Solidago juncea* Ait.

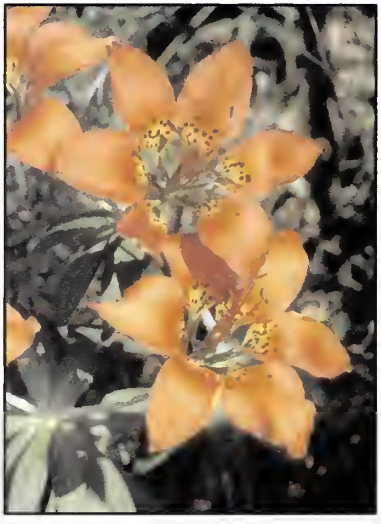
Asterales: Asteraceae (Aster Family)

A herbaceous plant 1.5–4.0 feet (0.5–1.2 m) tall; stem and leaves smooth, with tiny leaflets in the axils of the slim, toothless upper leaves; lower leaves large, toothed and tapering at base.

Goldenrods are typical autumn flowers, and they grow in a great variety of habitats. Early goldenrod occurs on dry soils at edges of wooded areas and in open woods from Nova Scotia to Georgia, west to Saskatchewan and Missouri. In the Pine Bush it is one of the earliest goldenrods to bloom, with flowers appearing in August. There is some evidence that early goldenrod increases in abundance following field fires, unless the field is dominated by little bluestem, which increases dramatically following fire (Swan 1970). Adult locust borers (*Megacyllene robiniae*) eat goldenrod pollen and nectar. These 0.5- to 0.8-inch (1.3- to 2.0-cm) velvety black long-horned beetles with golden-yellow stripes are often found on goldenrod inflorescences. Their larvae consume sapwood of black locust trees.

Goldenrods are perennial herbs with wand-like stems and stalkless leaves. Thirteen species

and varieties have been reported from the Pine Bush, and 11 of them have been confirmed in recent years. Accurate identification can be difficult. White goldenrod (*S. bicolor*) has white flowers, but all other Pine Bush species have gold or yellow flowers. Zig-zag goldenrod (*S. flexicaulis*) has flowers arranged in small clusters in the upper leaf axils along a zig-zag stem. Spreading goldenrod (*S. patula*), also known as rough-leaved goldenrod, has leaves harsh and rough on the upper surface, the stem sharply four-angled, and flowers arranged along long, spreading branches. Wreath goldenrod (*S. caesia*), hairy goldenrod (*S. hispida*), and downy goldenrod (*S. puberula*) have flowers arranged in small, short-stalked clusters in the axils of the upper leaves, forming cylindrical spikes or wands. Six species (cutleaf goldenrod [*S. arguta*], Canada goldenrod [*S. Canadensis*], late goldenrod [*S. gigantea*], early goldenrod [*S. juncea*], rough goldenrod [*S. nemoralis*], and tall-hairy goldenrod [*S. rugosa*]) have flowers arranged in plume-like heads along the upper sides of long, spreading branches. For many years goldenrods were considered a major cause of hay fever, but experiments with pollen have indicated that they are virtually harmless.



## Wood Lily

*Lilium philadelphicum* L.

Liliales: Liliaceae (Lily Family)

A herbaceous, bulbous perennial, 1–3 feet (0.3–0.9 m) tall; stem smooth; leaves in whorls; flowers facing upward, 2 inches (5 cm) across, red-orange, spotted, with stalked petals and sepals.

Wood lily is a striking native plant found from Maine and southern Quebec south to North Carolina and from British Columbia to New Mexico. Despite its common name, this showy species is usually found in relatively dry, somewhat open sites, such as among the scrubby oaks and grassy openings of the Pine Bush. It is distinguished by the whorled leaves and one to five upward-opening, orange flowers with purplish-brown spots. Wood lily flowers in mid-summer, from mid June to early July in the Albany Pine Bush. It reproduces from seed and vegetatively from white underground bulbs that lie about 2 inches below ground level. When mature, these bulbs are composed of several dozen starchy scales that can be dispersed by animals and form new plants at favorable sites. Native Americans gathered the bulbs for food. Wood lily is becoming increasingly difficult to find and should not be picked or dug up.

Although eastern populations of wood lily are usually found in drier woodlands on acid, sandy loams, midwestern individuals, which have only the upper leaves in whorls, grow in wetter situations. Wood lily should not be confused with the garden tiger lily, an introduced Asian species with nodding flowers, rough stems, leaves that alternate along the stem, and bulblets in the upper leaf axils. Canada lily, *L. canadense*, with nodding orange or yellow flowers, is a tall species, 2–5 feet (0.6–1.5 m), that can be found in moist areas in the Pine Bush.

## False Solomon's Seal

*Maianthemum racemosum L.*

Liliales: Liliaceae (Lily Family)

A perennial herbaceous plant, 1–3 feet (0.3–0.9 m) tall; stem slightly zig-zag, arching; leaves 3–6 inches (8–15 cm) long, broad, pointed, stemless, in two rows, alternating along stem, parallel-veined; flowers tiny, 0.13 inch (3 mm) long, white, in pyramidal or conical cluster at stem tip; fruit a round berry turning ruby red in September.

This perennial herb of woodlands and clearings occurs across southern Canada south through much of the United States. The flowers are conspicuous along Pine Bush woodland paths in June. Some Native Americans used the rhizomes and leaves to make medicinal teas as treatments for ailments ranging from constipation to insanity. Starry false Solomon's seal is a smaller plant with closely spaced leaves that clasp the stem, larger, starry flowers, and berries that turn black in autumn. The true Solomon's seals (*Polygonatum* spp.) have pairs of bell-shaped flowers falling from the leaf axils, in contrast to false Solomon's seal's cluster of small white star-shaped flowers at the tip of the stem.

## Starry False Solomon's Seal, Starflower

*Maianthemum stellatum* L.

Liliales: Liliaceae (Lily Family)

A rhizomatous perennial plant, 8–26 inches (20–66 cm) tall; stem erect, very leafy; leaves oblong, tapered, sessile or slightly clasping stem, in two rows, alternating along stem; flowers small, 0.25 inch (6 mm) long; flower cluster simple, with up to 10 flowers; fruit a round berry, turning nearly black in fall.

This species occurs across much of the United States and Canada, from New England to the Carolinas, and from Alaska to southern California. Starry false Solomon's seal is generally an indicator of moist environments, although it also occurs in well-drained situations, usually on limy soils. It regenerates primarily through rhizomes, which grow rapidly and develop into long, complex systems. Roots steadily die off so that the oldest rhizome segments have few roots remaining. Rhizomes can produce aerial stems, annual shoots that normally bear seven to nine leaves and occasionally produce flowers at the tip. This species can survive mild fires by sprouting from surviving rhizomes located in mineral soil. However it can be killed by fire that removes the duff layer and heats the upper mineral layer. Ruffed grouse eat the berries in the fall.

## Strawbell

*Uvularia perfoliata* L.
Liliales: Liliaceae (Lily Family)

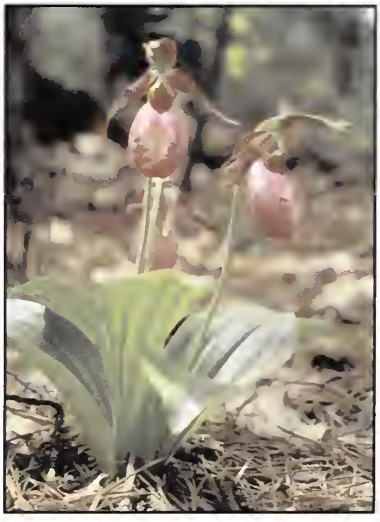
A herbaceous perennial with short rhizomes, 6–18 inches (15–46 cm) tall; leaves oblong, 1.5–4.5 inches (4–11 cm) long, smooth above and below, covered with a white bloom, appearing as if impaled by stem; flowers solitary, about 1 inch (2.5 cm) long, yellow, bell-like, nodding, at top of forking leafy stem; sepals and petals rough and granular within.

Strawbell, also known as perfoliate bellwort, grows in moist, thin woods and thickets on acidic to neutral soils from Massachusetts and southern Ontario to Florida and Louisiana. These lilies flower along Pine Bush woodland paths from early May to early June. They occur in the pitch pine–scrub oak barrens, pitch pine–oak forests, and ravine forests.

Two other species of *Uvularia* grow in small colonies in the Pine Bush. Large-flowered bellwort, *U. grandiflora*, more common outside the Hudson Valley and Ontario Lowlands, also has leaves pierced by the stem, but they are pubescent below. Its flowers are larger and smooth inside. Wild-oats, *U. sessilifolia*, more common in coastal regions, has much smaller, unstalked and unpierced leaves.

## Pink Ladyslipper

*Cypripedium acaule* Ait.
Orchidales: Orchidaceae (Orchid Family)



A herbaceous perennial, about 6–16 inches (15–41 cm) tall, pubescent, with two opposite, elliptic, pleated basal leaves, 4–8 inches (10–20 cm) long; flower to 2.5 inches (6 cm) high, solitary, with leaf-like bract arching over red-veined, elongated, inflated, slipper-like pink lip petal and lanceolate lateral petals and sepals.

Pink ladyslipper, also known as moccasin flower, occurs from Newfoundland south to Georgia and Saskatchewan south to Alabama. It grows in both hardwood and conifer woodlands, in swamps and bogs, and on sand hills. At the present time this orchid is remarkably abundant in the Pine Bush. Acid, nutrient-poor, woodland soils and light shade from the pitch pine canopy provide optimum conditions. Spring fires can kill plants or severely impair growth (Schweitzer and Rawinski 1988). Plants derive some nutrients from symbiotic fungi that decompose fallen pine needles. In the Albany Pine Bush, this large, exquisite orchid flowers in May. Bumblebees, which are lured into the flower's pouch and are essential to pollination success, soon learn that pink ladyslippers offer them no reward, and they learn to avoid *C. acaule*. Pollination and fruiting rates tend to be very low. Pink ladyslipper has a reputation for being very difficult to propagate, rarely surviving transplanting to gardens and requiring many years to mature from seed to flowering plant. Native orchids are protected by law in New York State. They may not be legally gathered or removed from a plot of land without the permission of the landowner. Native Americans used this orchid as a love medicine and a remedy for a number of disorders, including nervousness (Duke 1986).

## Deer Tick

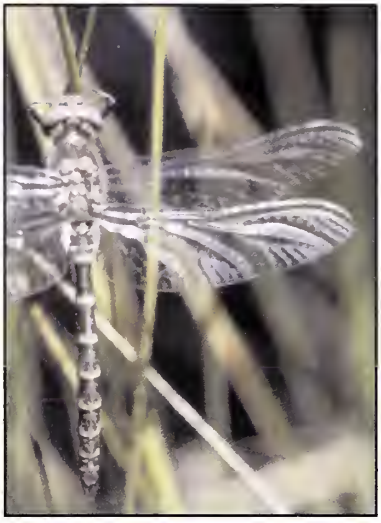
*Ixodes scapularis*

Acari: Ixodidae

Adult about the size and shape of a sesame seed when not fed, increasing to about 0.13–0.25 inch (3–6 mm) when engorged with a blood meal, dark reddish brown; hard dorsal plate (scutum) uniformly colored; with four pairs of legs. The American dog tick is larger, and its scutum bears white markings.

Deer ticks occur in the eastern half of the United States, where they live in shrubby and wooded areas and adjacent grasslands. They have a 2-year life cycle, and they take their meal of blood only three times. In spring and summer, six-legged tick larvae hatch from eggs in the soil, and they feed on blood of mice, other small mammals, and birds in summer and early fall. The next spring they molt into eight-legged nymphs, which feed on blood of small mammals and birds in late spring and summer. White-footed mice and chipmunks are important hosts for larvae and nymphs. In the fall nymphs molt into adults, which feed and mate on large mammals, especially deer, in the fall and early spring. A relationship has been observed between the abundance of deer and the abundance of deer ticks. Female ticks drop off their hosts and lay eggs on the ground. Ticks are known to be active at temperatures above 35° F (2° C). When taking a casual stroll through the Pine Bush on a warm autumn or spring day, it is advisable to check frequently for adult ticks on clothing. Homeowners in the Pine Bush area commonly find deer ticks on their dogs, especially from February to May.

Lyme disease is now the most common arthropod-borne illness in the United States. It is a noncontagious, inflammatory condition caused by the spirochete bacterium *Borrelia burgdorferi*, transmitted by the bite of the deer tick. Ticks become infected with Lyme disease bacteria in their younger stages, when they feed on small animals, especially the white-footed mouse. Nymphs and adults transmit the disease to other animals, including humans, dogs, and cats. Most Lyme disease cases are caused by bites of nymphal ticks from May through August, and the bitten individuals may be unaware of them because the nymphs are so small and their bites are painless. The autumn bites of larger adult ticks are more easily spotted. Only a small percentage of individuals reporting bites by known tick vectors in established endemic areas become infected with the disease. Early stages of Lyme disease are marked by fatigue, chills and fever, headache, muscle and joint pain, swollen lymph nodes, and a characteristic skin rash, *erythema migrans*, which appears within a few days to a month after the bite of an infected tick. The characteristic skin lesion of acute infection occurs in up to 80 percent of Lyme disease patients. It is a ring of redness that slowly expands from the site of the tick bite, and it often shows central clearing, producing a bull's eye appearance. Later stages of the disease can involve cardiac, arthritic, or neurological symptoms.



*Courtesy Ginger Carpenter*

## Lintner's Bog Skimmer

*Williamsonia lintneri* (Hagen)
Odonata: Corduliidae (Green-eyed Skimmers)

A small, delicate dragonfly, about 1.4 inches (3.5 cm) long and generally dark colored; face orange-brown; wings clear, unmarked, wingspan about 1.8 inches (4.5 cm); abdomen black or dark brown, about 0.9 inch (2.3 cm) long, most segments with pale yellow-orange ring at apex. Easily recognized by the early flight season, small size, and pale abdominal rings of the adults.

The current verified range of Lintner's bog skimmer includes sites in New Hampshire, Massachusetts, Connecticut, Rhode Island, and New Jersey. However, the first specimens of this species that came to the attention of scientists were collected by Dr. Joseph A. Lintner, State Entomologist at the New York State Museum, in the Albany Pine Bush during the 19th century. The species was named and described in 1878, and since then it has not been found again in New York State. In recent years some conservation biologists have called this species the ringed or banded boghaunter dragonfly. It seems preferable to honor the intentions of the taxonomist who described and named it by promoting a common name that recognizes the discoverer of the species. Most of the living population today occurs in Massachusetts, where it is found primarily in sedge fens and certain sphagnum bogs surrounded by woodlands. Adults of this rare and inconspicuous species are among the first dragonflies of the season, and they can be seen along woodland trails near breeding sights on warm days from late April to early June. Nymphs develop in open, shallow pools, 6–12 inches (15–30 cm) deep, where they feed on aquatic invertebrates. Highbush blueberry, sheep laurel, and leatherleaf are typical plants of Lintner's bog skimmer habitat. Nymphs emerge from the water in April and transform into winged adults, which lay eggs and die by mid June. Adults feed on insects that they catch in flight, but they spend most of their time basking on tree trunks, rocks, trails, and roads in sunny openings in the forest.

## Antlion

*Myrmeleon immaculatus* De Geer
Neuroptera: Myrmeleontidae (Antlions)

Adults damselfly-like, 1.4 inches (3.6 cm) long; antennae clubbed, about as long as head and thorax combined; wingspan 2.5 inches (6.4 cm); wings clear, unspotted, with pointed tips; abdomen long, slender, tube-like. Larvae about 0.6 inch (1.5 cm) long, tan, with long sickle-like jaws. Presence of larvae confirmed by presence of cone-shaped pits in sand, each 1.5–2.0 inches (4–5 cm) in diameter.

This species occurs all over the United States and reaches into Canada, but it is most common in the Southwest. Both adults and larvae are predators. Adults, which commonly feed on caterpillars and aphids, are feeble-fliers on the wing at night. The pitfall traps of the larvae are especially abundant in protected areas under overhanging sod along the eroded sides of Pine Bush paths. Larvae, sometimes

called doodlebugs, lie buried beneath the sand at the bottom of the pits, waiting for ants and other ground insects to tumble down the loose sand grains that form the sides of these depressions. Any disturbance of the sand at the bottom of a pit will evoke a violent reaction from the larva. Larvae are easily collected by sifting the sand with a flour sifter or tea strainer. They pupate in the sand, in a cocoon made of sand and silk.

## Tiger Beetle

*Cicindela scutelaris lecontei* Haldeman
Coleoptera: Cicindelidae (Tiger Beetles)

About 0.5 inch (1.3 cm) long; metallic purplish to greenish bronze; wing covers (elytra) smooth, not punctate, with extensive white markings of wing covers (elytra) restricted to outer edge, lacking markings at center.

This common Pine Bush predator is usually found in spring and fall in open, dry, sandy localities with sparse vegetation, like dunes and dry pathways, where it is often associated with the larger and more robust dry dune species, *C. formosa*, which has a much bolder and more extensive pattern of white marking on the elytra. Larval burrows occur in loose, deep, well-drained sand. Other Pine Bush tiger beetles prefer richer soils (*C. punctulata*), moist sand (*C. repanda, C. duodecimguttata*), or open woodland (*C. sexguttata*). Adults of *C. scutellaris* are wary and will take flight or retreat to nearby sparse vegetation when disturbed. They begin to appear from hibernation in April and are frequently seen until July. These spring adults soon mate and lay eggs in small holes or depressions in deep, dry sand. The larvae, which are also predators, live in burrows that extend vertically 1–2 feet deep. There they wait for suitable prey to pass by. They are prone to intense parasitism by bombyliid flies. The elongate, cylindrical, grub-like larvae are up to an inch (2.0–2.4 cm) long and soft-bodied, except for the well-armored head and pronotum, which guard and close off the burrow entrance. A prominent dorsal projection on the fifth abdominal segment bears large forward-directed hooks that hold the larva in place when other predators try to pluck it from its burrow. Larvae reach the third and final instar in August or September and then close their burrows and hibernate. The following spring, they feed until the middle of June and pupate in July. Adults emerge in September and October. They hibernate and become sexually mature the following April. Two years pass between generations (Hamilton 1925; Knisley and Schultz 1997).

Tiger beetles are sensitive to human encroachment. Species have disappeared from many habitats well trodden by human visitors or disfigured by ATV traffic, developed for housing or industry, or subjected to insecticides. The barrens tiger beetle, *Cicindela patruela* Dejean, has not been seen in the Pine Bush since the 19th century, and it is now quite rare throughout its range, which extends from the Northeast west to Minnesota and south to Georgia. This elusive species has been collected in isolated sandy areas of the New Jersey Pine Barrens in mid to late afternoon (Boyd 1973). It is an iridescent green species, similar to *C. sexguttata*, but it has characteristic large white markings that extend toward the center.

## Pine Needle Miner

*Exoteleia pinifoliella* (Chambers)
Lepidoptera: Gelechiidae (Gelechiid Moths)

Presence is recognized by browning of pitch pine needles. Mature caterpillars 0.2 inch (5 mm) long. Adult moths gray and brown; wingspan about 0.4 inch (1 cm).

Sometimes and in some places, the pitch pines of the Albany Pine Bush display a sickly and alarming brownish cast due to needle death caused by the pine needle miner. Pitch pine is the primary host of this native pest. In late spring or early summer, females lay eggs in exit holes in recently vacated, mined needles. The newly hatched larva leaves the old needle and enters a young needle near its base. The larva consumes most of the interior tissues of this first healthy needle, which turns yellow and dies within 2–3 weeks. It vacates this needle after its second molt and enters the apical end of a second healthy needle, where it feeds for the summer and fall and spends the winter as a fourth instar larva in a cocoon-like chamber of loose silken threads. In its second spring, the larva continues to mine the second needle. It consumes all the internal tissues while moving toward the base of the needle and packing frass pellets tightly in the apical end. It molts for the fourth time before cutting a round exit hole about a third of the length from the base of the needle. It then enters yet another needle a little below midway and mines toward the apex. It lines the mine and seals the entrance hole with silk and pupates in this third needle. Adults emerge in late spring. The second and third needles are killed only as far back as the entrance or exit holes, giving heavily infested trees an unhealthy appearance. Finnegan (1965) reported that the pine needle miner can cause defoliation and death of jack pines in Canada.

## Dusted Skipper

*Atrytonopsis hianna* (Scudder)
Lepidoptera: Hesperiidae (Skippers)

*Lower: Courtesy Robert Dirig*

Wingspan 1.1–1.4 inches (2.8–3.6 cm); antennae widely separated, with swollen tip curved or hooked; fore wings pointed at tips, brown on top, darkest near base, with irregular, curved row of small white dots (larger in female than in male) about one-third distance from outer margin, and one or two spots near front edge about halfway from outer margin; hind wing gray underneath, with a small white dot near base. Similar to Juvenal's dusky wing, but smaller and lacking the dark spots and the rows of buff spots near wing margins.

Skippers are powerful and rapid fliers that move erratically in a darting or skipping fashion. The smooth larva, which has a large head capsule and a constricted neck, feeds inside a leaf shelter, and pupation occurs in a cocoon made of leaves fastened together with silk.

The uncommon and highly localized dusted skipper occurs from southern New England south to Florida and west to Wyoming, Colorado, Oklahoma, and Texas. New York populations are limited to Long Island and the Husdon Valley sandplain. It

is very local and rarely observed in the Albany Pine Bush, although it was seen at three sites here in 2001 (R. Dirig, personal communication). The species prefers open, dry, disturbed areas, and it shifts about and colonizes freshly burned areas readily. In addition to pine-oak barrens, it can be found in old fields on acid soils, woodland openings, and utility rights-of-way. There is only one generation each year, and adults fly from mid May into June. Adults take nectar from honeysuckle, blackberry, and clover. Females lay bright yellow eggs on host grasses. Little bluestem (*Schizachyrium scoparium*) is the preferred caterpillar host, although big bluestem (*Andropogon gerardii*) is sometimes used. The caterpillars are pale lavender on the back, fading to gray along the sides and behind the head. The anal segment is brown with a dark shield, and the head is deep reddish purple. The body is covered with long cream hairs. Larvae construct shelters by tying several grass blades together. The mature larva winters in a sealed shelter at the base of a clump of grass.

## Silver-spotted Skipper

*Epargyreus clarus* (Cramer)
Lepidoptera: Hesperiidae (Skippers)

A large skipper; wingspan 1.8–2.6 inches (4.6–6.6 cm); antennae widely separated, with swollen tips curved or hooked; wings dark brown to black; fore wing with broad, angular, translucent gold patch; hind wing with small, blunt posterior lobe and distinctive metallic silver patch on underside.

This large, conspicuous, and easily identified skipper occurs in disturbed and open forest situations in southern Canada, most of the continental United States, and northern Mexico. Adults select many kinds of summer flowers, especially pink, red, and purple flowers, as nectar sources. Males perch on leaves and twigs and pursue large insects that come within range. Their rapid, darting flight is often difficult to follow. Females deposit eggs singly on leaves of food plants. The caterpillar's preferred host is black locust, which is abundant in the Pine Bush, but it will also consume leaves of sticktight (*Desmodium*), bush-clover (*Lespedeza*), and other legumes. The larva is light yellow, with fine, dark lines crossing from side to side over the back. Its head is rust-red and has two large, round, yellow-orange spots low on the front. Caterpillars cut and fold leaflets of compound-leaved legumes to create shelters, abandoning older shelters as they grow. Larger and more mature individuals require larger shelters, which may consist of several leaflets. This species has more than one generation each year, and it seems that adults are present all summer after their first appearance in late May. Large numbers of them appear in July. The species winters as pupae.

## Dreamy Dusky Wing

*Erynnis icelus* (Scudder and Burgess)
Lepidoptera: Hesperiidae

Small skipper; wingspan 0.9–1.3 inches (2.3–3.3 cm); antennae widely separated, with swollen tip curved or hooked; wings dark brown to black; fore wing lacking glassy spots, but with patch of gray scales near margin, about one-third distance from wing tip.

The dreamy dusky wing occurs across southern Canada south to Georgia, Indiana, New Mexico, and California. It is found along roadsides, trails, woodland edges, and in forest clearings. Males gather at moist, sandy areas along streams or at wet depressions in roads and trails. Females flit among low vegetation at the edges of woods and in brushy areas, laying eggs one at a time on new leaves and stems of host plants. Caterpillars feed on willows, poplars, aspens, and birches. They are light green with white specks; thin, white lateral stripes; and a dark dorsal stripe. The head is orange-brown with a row of large yellow spots along the outer edge. The caterpillar winters in a leaf shelter and pupates in spring. Adults emerge in late April, and fly through June and perhaps into July.

A related species, the Persius dusky wing (*Erynnis persius*), occurred historically in the Long Island and Albany Pine Barrens, but it has not been found in New York State since 1985. The caterpillars fed on lupine.

## Juvenal's Dusky Wing

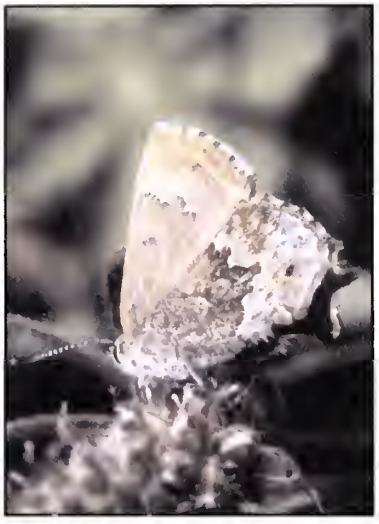
*Erynnis juvenalis* (Fabricius)
Lepidoptera: Hesperiidae

Medium-sized skipper, wingspan 1.4–1.6 inches (3.6–4.1 cm); antennae widely separated, with swollen tip curved or hooked; wings brown; fore wing with many small, glassy spots, mostly in a curved line about one-quarter distance from outer margin, and one or two spots near front edge about halfway from outer margin. Distinguished from dusted skipper by larger size, fore wing with many scattered dark spots, and fore and hind wings each with two conspicuous rows of buff spots near outer margin.

Juvenal's dusky wing occurs from southeastern Canada west to Manitoba, and from the eastern United States west to Texas, Arizona, and northern Mexico. This common skipper is found in open woods and along roads, trails, and field edges. Freshly emerged males gather at moist sand or mud to imbibe fluids. Males searching for receptive mates perch on twigs or bare ground when they are not busy patrolling. Caterpillars develop slowly, feeding on a variety of red and white oaks. The caterpillar is light green with white specks and a thin, white lateral stripe. It is thickly covered with fine, short hairs. The head is orange brown with a row of large yellow spots along the outer edge. Adults appear in April, and their flight continues into June. Like other dusky wings, they rest at night with their wings folded roof-like, much like a moth. During the day,

they bask with wings spread.

A related species, the mottled dusky wing (*Erynnis martialis*), is now found in New York State only in the Pine Bush, although in earlier times it was known from Rockland County, Long Island, and elsewhere. Its caterpillars feed on New Jersey tea.



## Frosted Elfin

*Incisalia irus* (Godart)

Lepidoptera: Lycaenidae (Gossamer Wing Butterflies)

Wingspan 0.9–1.1 inch (2.3–2.8 cm); wings of male gray-brown above, with long, narrow scent patch on upper surface of fore wing near front margin; wings of female reddish brown above; underside of fore and hind wing in both sexes brown at base, lighter gray brown and checkered at apex, the two areas separated by distinctly irregular dark line often bordered in white crossing at midwing; base of hind wing darker than base of fore wing; hind wing frosted below, margin scalloped, tipped with short tail stump; a small dark brown spot present near base of tail.

The frosted elfin is found in the eastern United States, where it inhabits dry, open areas along woodland edges, brushy fields, and oak-pine habitats. In New York State it is known from the pine barrens of Long Island and the Hudson Valley. In the Albany Pine Bush, this little brown butterfly is found among patches of lupine in the spring during, or just before, the late May to mid June flight period of the Karner blue butterfly. Here caterpillars feed by boring into flower heads and young pods of wild lupine; they also consume small, young, terminal leaves. Elsewhere, they also consume wild indigo (*Baptisia tinctoria*). Caterpillars are pale bluish-green with short, pale hairs, a pale lateral line, and rows of short, oblique lateral lines. They are usually active a little later than Karner blue caterpillars, maturing in early June in a typical year, and they can be distinguished from Karner blue caterpillars by their paler green color and green head capsules. They pupate and pass the winter in leaf litter at the base of the host plant. There is only one generation per year. Frosted elfin populations in the Albany Pine Bush are in decline because of the disappearance of lupine as a result of fire suppression. The butterflies are also vulnerable to insecticide spraying. In the Pine Bush, this little butterfly has even disappeared from some of the smaller patches of lupine.

Four species of elfins (genus *Incisalia*) have been found in the Albany Pine Bush. Brown and eastern pine elfins lack the short tail stump found on the hind wings of Henry's elfins and frosted elfins. Henry's elfins lack the small dark spot found on the hind wing of the frosted elfins, near the tail. The postmedian line on the underside of the fore wing is nearly straight in Henry's elfins, but very jagged in the frosted elfins. Henry's elfin caterpillars feed on huckleberry and a number of other plants. Recent New York State records for this species are confined to the Albany Pine Bush.

## Karner Blue Butterfly

*Lycaeides melissa samuelis* Nabokov

Lepidoptera: Lycaenidae (Gossamer Wing Butterflies)

Wingspan 0.9–1.3 inches (2.3–3.3 cm); upper wing surface of male iridescent gray-blue with narrow black margin; upper wing surface of female gray-brown with bluish cast centrally; upper surface of female hind wing margined with a row of four to five orange-bordered dark spots along rear margin; lower wing surface in both sexes silver-gray, with a continuous black marginal line and row of orange-bordered, iridescent blue-green spots along rear margin of both front and hind wings; hind wing without tail or stub. This is the only small, blue, tailless butterfly in the Albany Pine Bush with a submarginal band of orange spots on the underside of the hind wing, and it rarely occurs outside of patches of lupine. However, it could be confused with the eastern tailed blue, which is distinguished by the fine tail on the hind wing and only two to three submarginal orange spots on the underside of the hind wing near the tail. The spring azure lacks orange wing spots. The hairstreaks have wings with darker brown to gray undersides and tails on the hind wings.

The Karner blue is apparently a relict form of the Melissa blue butterfly that moved eastward during a warm postglacial period. Typical Melissa blues occur in southwestern Canada, the northern plains, and the western states to northern Baja California in Mexico, where they inhabit dry mountain meadows. Melissa blue larvae consume legumes, including various lupines, alfalfa, crazyweed, and wild licorice. The Karner blue subspecies, *Lycaeides melissa samuelis,* occurs in small isolated populations in New England and New York, across southern Ontario, and into the northern Midwest. This eastern form survives in sandy pine barrens habitats. In New York State, it occurs in small colonies throughout the Hudson Valley sandplain at sites where wild lupine thrives. Novelist and lepidopterist Vladimir Nabokov, while working at Harvard University's Museum of Comparative Zoology, formally and scientifically described the subspecies in 1943 from a male specimen. That holotype specimen was presumably reared from eggs laid by a Pine Bush female collected by famed butterfly expert Samuel H. Scudder in the spring of 1887 (Dirig 2003; Nabokov 1943; Scudder 1889).

Adult Karner blue butterflies are found flying in patches of lupine during daylight hours. Females lay eggs on or near the host plant, and these hatch in about a week. Larvae feed exclusively on wild lupine, devouring all but the upper cuticle and leaving characteristic translucent windows in the leaves. Caterpillars are tended by ants, which consume honeydew, consisting of sugars and amino acids, secreted from caterpillar glandular structures. Caterpillars of all sizes are attended, but more ants attend larger caterpillars (Swengel 1995). At least 19 species of ants engage in this activity in the Albany Pine Bush, where it has been demonstrated that ant attendance significantly enhances larval survival (Savignano 1994). It is believed that ants protect the caterpillars from predators and parasites.

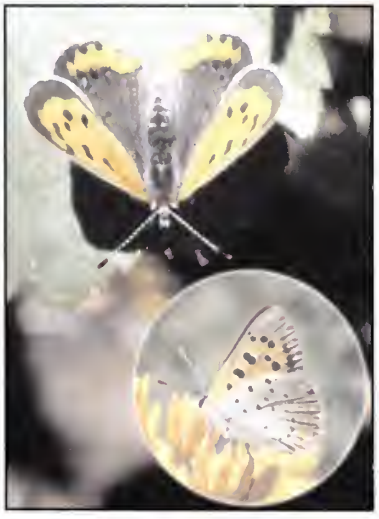
The dorsoventrally flattened Karner blue larva is green and has a darker green dorsal stripe, pale lateral stripes, and a covering of short, pale brown hairs. It is easily distinguished from the otherwise similar frosted elfin larva by its darker pea green color and black head capsule. The head capsule of frosted elfin caterpillars is green (T. L. McCabe, personal communication).

The Karner blue has two broods each year, with adults appearing from late May to mid June and again in July and early August. The second brood is usually larger than the first. Eggs from this brood, laid among litter at the bases of lupines or on lupine pods, stems, or leaves, pass the winter and hatch in April. Autumn or spring fires in lupine patches are likely to kill Karner blue eggs (Swengel 1995). Karner blue butterflies cannot survive at a given site indefinitely. Instead,

subpopulations disappear and appear across the landscape, taking advantage of newly established habitat that results after a disturbance such as fire. At the time of this writing, Karner blues are uncommon within the protected Pine Bush Preserve area.

The Karner blue butterfly is the most famous insect of the Albany Pine Bush. Historically the subspecies occurred much more widely and abundantly than it does today. A well-known passage in Nabokov's novel *Pnin* (1957) depicts these butterflies as "blue snowflakes" floating above wet sand. Robert Dirig (1996) recalls that small blue butterflies "once swarmed by the millions near Albany, New York." Acres of lupines once grew in the area where the state office building campus and the University at Albany now stand, and multitudes of Karner blues filled the air above them. It is said that as many as 30 of them could be caught with a single sweep of a butterfly net (Dirig and Cryan 1975). Within the past 10–15 years, the subspecies' abundance in the Pine Bush has collapsed by more than 95 percent, and its overall distribution has become ever more restricted due to massive destruction and degradation of critical habitat. The Karner blue subspecies is in serious decline because of a substantial reduction in the number of lupine plants. Populations have become so thin that colonies have even disappeared from some lupine stands in recent years. This reduction has been caused by land development, which significantly reduced lupine populations, and by ecological succession, which has been encouraged by fire suppression policies of recent decades. It would seem that the multitudes of butterflies are gone forever.

This tiny blue insect could have easily slipped unnoticed into extinction, but it managed to capture the imagination of environmentalists and is now a symbol of endangered species, taking rank with the likes of the wolf and the peregrine falcon. In 1977 it became the first insect to be officially listed as endangered in New York State. In 1980 the result of months of heated public hearings pivoted on testimony regarding the fate of the Karner blue, with evidence suggesting that construction of Crossgates Mall in the Pine Bush would endanger the Karner blue and the buck moth. The New York State Department of Environmental Conservation required that the company building the mall set aside acreage as a butterfly preserve (Stewart and Ricci 1988). The U.S. Fish and Wildlife Service officially assigned the Karner blue butterfly endangered status on December 14, 1992 (Andow et al. 1994).



## American Copper

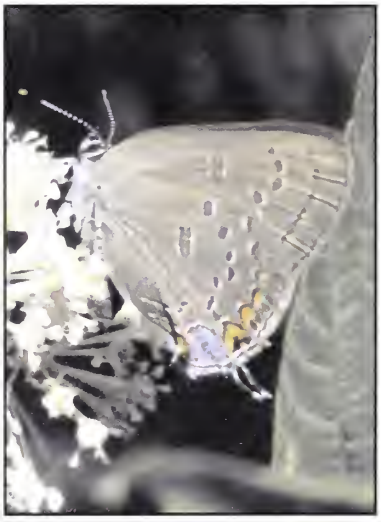
*Lycaena phlaeas* (Linnaeus)

Lepidoptera: Lycaenidae (Gossamer Wing Butterflies)

Wingspan 0.9–1.1 inches (2.3–2.8 cm); fore wing on top bright, iridescent red-orange with several scattered dark spots and a wide gray-brown margin; underside similar but paler; hind wing on top gray-brown, with a wide copper margin containing a row of dark spots; underside gray with small black spots and a narrow scalloped copper line near outer margin. Specimens could be confused with female bronze coppers (*Lycaena hyllus*), but the latter are larger, lighter orange or yellowish, and they occur in wet areas. There is a broad orange marginal band on the underside of the bronze copper's hind wing.

The American copper occurs in abundance in the Northeast and is less common and locally distributed in the southern Appalachians and Midwest. The species is widespread, occurring also in Europe, Asia, and some East African mountains. Some entomologists believe it was introduced into North America from Europe during colonial times, but the evidence to support this claim is inade-

quate. The northeastern American population has been referred to the subspecies *Lyceaen phlaeas americana* Harris, which appears to be very similar to the European population. It occurs from Nova Scotia south to Georgia, and west to northwestern Ontario, Minnesota, and Arkansas. Three other North American subspecies occur in arctic and subarctic areas of Canada and western mountainous regions. American coppers can be found in dry areas, including open fields, meadows, roadsides, pastures, and gardens. Despite their small size, they are among the most conspicuous butterflies of the Albany Pine Bush. Adults take nectar at a wide variety of flowers. They bask with their wings open, and they are very pugnacious, chasing off other butterflies that intrude on their territory. Females deposit single, light green eggs on leaves of the host plants, sheep sorrel (*Rumex acetosella*) and curly dock (*Rumex crispus*), both naturalized from Europe. Larvae rest at the base of the plant and crawl up to the leaves to feed, chewing grooves or slots in them. They do not look like typical caterpillars. They are rosy red to yellowish-green in color, with varying red to white stripes, and they are covered with short white hairs, flattened, and three to four times as long as wide. There are probably three broods each year, and adults fly May through September. The species probably winters as an egg or first instar larva within the egg.



## Edward's Hairstreak

*Satyrium edwardsii* (Grote & Robinson)
Lepidoptera: Lycaenidae (Gossamer Wing Butterflies)

Wingspan 1.0–1.3 inches (2.5–3.3 cm); fore and hind wing brown above, gray-brown below, each wing underneath with a streak of distinct white-edged spots (not joined to form a chain) about one-quarter or one-third distance from outer wing margin, and another much nearer outer margin; hind wing beneath at apex with pale blue patch or lunule (this patch lacking a well-developed orange cap), short series of orange crescents, and short, narrow, hair-like tail; male with long, narrow scent patch on upper surface of fore wing near front margin.

Edward's hairstreak is found from extreme southeastern Canada and Maine to Georgia in the east and from southeastern Saskatchewan to northern Texas in the west. It is often found in association with scrub oak thickets and other vegetation in dry, acidic habitats. Adults are often seen visiting flowers of milkweed, New Jersey tea, dogbane, and other plants along trails and woodland edges. Males perch on twigs and leaves to await females, and they aggressively pursue other males. Females place eggs singly in oak bud axils. The preferred larval food is scrub oak foliage, *Quercus ilicifolia*, but they also use scarlet, black, and white oak. Young larvae eat the buds. Older larvae live in nests at the base of the host oak and feed on the leaves at night. They are attended by ants, which feed on their honeydew secretions. The brown, lightly haired caterpillar has a dark middorsal band, a series of light spots arranged in a lateral line, and oblique dashes along the body. Edward's hairstreak has only one generation per year, and adults fly from mid June to late July.

There are five hairstreaks of the genus *Satyrium* in the Albany Pine Bush. All have a small blue patch, or lunule, on the underside of the hind wing near the tail. Only Edward's, banded, and hickory hairstreaks lack a well-developed orange cap over the blue lunule. The distinct, rounded, light-margined spots on the undersides of the wings distinguish Edward's hairstreak. In the banded and hickory hairstreaks, these spots are rather rectangular and joined to form bands. Like Edward's hairstreak, the banded hairstreak lives in open woodlands, but adults tend to fly a little later, and its larvae will feed on a number of plants (particularly butternut) in addition to a variety of oaks.

## Inland Barrens Buck Moth

*Hemileuca maia* (Drury)

Lepidoptera: Saturniidae (Giant Silkworm and Royal Moths)

Wingspan 2–3 inches (5–8 cm); fore and hind wings jet black with wide, white median bands; abdominal apex red in male, black in female.

The buck moth occurs from Maine to Florida and west to Wisconsin and Texas. The Albany Pine Bush is close to the northernmost limit of its distribution. In New York State, it also occurs as a morphologically and behaviorally distinct form in the pine barrens of Long Island. Caterpillars of the inland form are black with tiny white specks, lacking the striping found in coastal populations. Larval spines can cause severe inflammation of human skin. *Hemileuca maia* is related to western moths, and it might be a relict remaining from a warm postglacial period. Buck moths inhabit areas with acidic, nutrient-poor soils that support the larval food plant, the scrub oak. The species is highly adapted to life in the dry, fire-regulated, pitch pine–scrub oak community, and populations may increase for several years in response to luxuriant postfire growth of scrub oak. Females lay eggs in neat rings or cylinders around scrub oak twigs. A thick coat of waterproof substance protects each egg from winter weather and imparts a golden shine. Although intense fall or spring fires are likely to kill buck moth eggs, low intensity fires are unlikely to reach them. After they hatch in May or June, young larvae feed in groups on young scrub oak leaves. Older larvae are solitary feeders. Mature larvae leave their host plants in July or August and pupate in sheltered spots at the ground surface or buried in sand up to 2 inches (5 cm) deep. Adults usually emerge within weeks, triggered by late September or early October rains, but in dry years some individuals overwinter as pupae buried in sand and emerge the following fall, or even up to 4 years later. The short-lived, non-feeding adults are most likely to be seen emerging and flying on sunny days in late morning and early afternoon. Females soon mate, lay eggs, and die. The name *buck moth* may have been given to this species because adults were noticed by deer hunters in late summer and early autumn. An erroneous 18th-century notion held that bucks breed the caterpillars in their heads and blow the moths out of their nostrils.

Only 25 years ago, the Pine Bush supported a vigorous population of buck moths (Dirig and Cryan 1975). Habitat destruction through fire suppression, which results in the elimination of scrub oak from the natural community, is the most important threat to this species. Its intimate association with the fire-regulated pitch pine–scrub oak community puts it in severe danger of being destroyed by human activity, urbanization, and fire suppression (Tuskes et al. 1996). It is listed as a species of special concern by the Endangered Species Unit of the New York State Department of Environmental Conservation, and it has received special attention from conservation officers in several New England states because of loss of habitat. The U.S. Fish and Wildlife Service lists the buck moth in its compilation of taxa native to the United States that are being reviewed for possible addition to the List of Endangered and Threatened Wildlife under the Endangered Species Act of 1973.

A rare related species of *Hemileuca*, known from sites in Oswego County, New York, and Ontario, Canada, has adapted to life in wetland habitats and feeds on the bog buckbean, *Menyanthes trifoliata* (Schweitzer 1992; Pryor and Bonanno 1996).

## Gall Wasps

Hymenoptera: Cynipidae (Gall Wasps)

Gall wasps of the family Cynipidae are restricted to a great degree to the oaks. Females lay eggs in actively growing tissues, or those that will grow the following spring. The feeding activity of the wasp larva causes the host plant to produce a growth, known as a gall, that is characteristic of the wasp species. All parts of the oak are affected: roots, bark, trunk, branches, twigs, leaves, buds, staminate and pistillate flowers, and acorns. The wasp larva feeds upon the elaborated tissues and pupates inside the gall. The adult chews a hole in the gall to escape. The sexual generation of *Callirhytis quercusoperator* (Osten Sacken) produces the woolly catkin gall (upper left photograph) of scrub oak flower clusters (aments) in spring; the agamic generation produces acorn galls. Woolly catkin galls are woolly masses up to about 3 inches (7.6 cm) in diameter, and they each contain 150 or more cells. *Dryocosmus imbricariae* (Ashmead) produces hard, one-celled banded bullet galls (lower right photograph), each 0.3–0.5 inch (8–13 mm) in diameter, on stems of red oaks, including scrub oak. *Amphibolips quercusilicifoliae* (Bassett) produces the conspicuous scrub oak galls (upper right photograph) of scrub oak leaves. These galls arise from a blade or petiole, and each contains a cell supported by filaments. *Xanthoteras quercusforticorne* (Walsh) forms clusters of soft, thin-shelled galls on stems of dwarf chestnut oak. They are often closely pressed together, and because of their resemblance to the fruit they are known as oak fig galls (lower left photograph).

## Allegheny Mound Ant

*Formica exsectoides* Forel

Hymenoptera: Formicidae (Ants)

Workers typically about 0.25 inch (6 mm) long; head and thorax red; gaster black or brown; head of worker distinctly concave behind; gaster with erect hairs confined to terminal segments.

The large, thatched nests of the Allegheny mound ant are conspicuous features of the Pine Bush landscape. This ant is also present, but rare, in all the coastal barrens, and it can occur in other open, warm habitats as well. A typical Pine Bush mound measures 3 feet (0.9 m) in diameter and extends over 5 feet (1.5 m) into the ground. Nests, which are not very complex, consist mostly of sand, but they also contain materials collected from surrounding areas and incorporated into the galleries and chambers that permeate the nest, particularly in the upper 12 inches (0.3 m). A characteristic blanket of litter, consisting of broken and sometimes charred bits of stems, leaves, and grass, rodent feces, and other organic materials typically covers each mound, perhaps trapping solar energy and reducing erosion of the mound crust by rain and wind. The Allegheny mound ant uses a complex ventilation mechanism, a thermosiphon driven by transient flecks of sunlight passing over the mound, in a simple structure not expressly designed for such a function (Voss and Turner 1996). In summer and early autumn, a great amount of activity is devoted to gathering

food, primarily insects, nectar, and honeydew from aphids that live on oaks and black locust. *F. exsectoides* is a polygynous species, having mounds containing multiple inseminated queens, and its populations act like single supercolonies occupying many mounds. Winged sexual forms are found in or near the mounds in midsummer, and wingless queens are found in late summer in peripheral galleries near the soil surface. Brood production is usually completed by midseason, when the number of large larvae and pupae peaks. Larvae and pupae are present in the upper few inches of the mound, but they are particularly abundant in the lowest nest depths, where humidity levels in the dry soils are most stable. It is assumed that many mounds are formed by a swarming process in which a portion of one mound or colony relocates and founds a new nest with one or more queens. When this can't be done, the young queen seeks the assistance of an allied species of *Formica*, the workers of which take the place of her own species in the rearing of her brood. Eventually the host workers die, leaving the parasitic queen and her offspring in possession of the nest. Older nests often become overgrown with vegetation, especially various grasses and sedges, and mounds can be extinguished by vigorous overgrowths of the common Pine Bush moss, *Polytrichum commune*.

*Rob Simpson/Visuals Unlimited*

## Mole Salamanders

*Ambystoma jeffersonianum* (Green) and *A. laterale* Hallowell

Caudata: Ambystomatidae

About 4–7 inches (10–18 cm) long, slender, bluish black to dark brown or gray dorsally, lighter ventrally; snout and toes long. Jefferson salamanders (*A. jeffersonianum*) with small bluish flecks laterally and on legs; vent surrounded by gray area. Blue-spotted salamanders (*A. laterale*) darker and usually with blue or bluish white spots on back and sides; vent surrounded by black area. The spotted salamander (*A. maculatum*) has yellow or orange spots. The former two species hybridize in areas where their ranges overlap, including most of New York State. Hybridization produces a bewildering array of patterns, making identification extremely difficult and uncertain (Bogart and Klemens 1997).

*Ambystoma jeffersonianum* and *A. laterale* occur in southeastern Canada, New England, New York, and much of the Great Lakes Region. The Jefferson salamander extends a little more south, and the blue-spotted salamander extends a little more north and west. Mole salamanders are common in Albany County, both inside and outside the Pine Bush. They usually occur in mature woodlands in New York State and are often extremely abundant along stream banks. Individuals wander on rainy nights but are rarely seen otherwise. However, both Jefferson and northern redback salamanders have been reported from Pine Bush dunes. They stay underground most of the time, but during early spring rains they migrate to pools and ponds to mate and lay eggs for a brief period. Egg masses are small and cylindrical, and they each contain 7–40 eggs. Mole salamanders eat earthworms and other invertebrates.

## Fowler's Toad

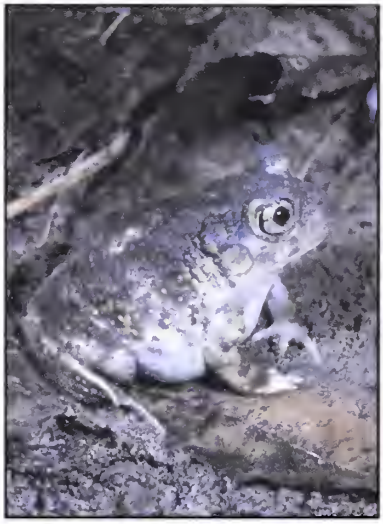
*Bufo fowleri* Hinckley

Anura: Bufonidae

About 2–3 inches (5–8 cm) long; similar to American toad (*Bufo americanus*), but each largest, dark dorsal spot with three or more warts; chest and belly virtually unspotted; tibia lacking enlarged warts; paratoid gland broadly touching cranial ridge behind eye.

The range of this species in New York State projects up the Hudson Valley from the more southern main body of the North American distribution, which extends to northern Florida and eastern Texas. In Albany County, Fowler's toads are rarely, if ever, found outside the Pine Bush. They prefer sandy, warm, moist areas, such as pine barrens, stream banks, and pond and lake shores. They breed from spring to late summer, calling with a short, penetrating, nasal cry (unlike the long, musical trill of the American toad) from temporary pools, shallow margins of permanent bodies of water, and flooded low ground.

*Courtesy Paul E. Meyers*



*Courtesy Paul E. Meyers*

## Eastern Spadefoot

*Scaphiopus holbrookii* (Harlan)

Anura: Pelobatidae

About 1.5–2.5 inches (4–6 cm) long; skin smooth, with scattered warts and two light dorsal stripes; raised area between eyes (boss) lacking, pupil vertical; hind foot with single, elongate, sharp-edged, sickle-shaped black spade; typical call a coarse, monosyllabic *wank*.

It seems that the Albany Pine Bush population of this species is separated from the main body of the North American distribution, which extends from extreme southern New England and New Jersey south through Florida and west through Mississippi and northeastern Arkansas. The eastern spadefoot formerly occurred more widely in the Albany area, but today, in Albany County, it is rarely, if ever, found outside the Pine Bush (Stewart and Rossi 1981). This nocturnal creature is rarely seen. It is adapted to life in dry areas and can remain underground for many weeks at a time. The spade on the hind foot enables it to dig backward, vertically downward into loose, sandy soil. It is often found at shallow depths, but it is capable of going several inches down. Spadefoots breed from spring to late summer, but only after heavy rains and often in temporary rain pools. The white, inflated throats of croaking males are said to resemble shiny white golf balls (Wright and Wright 1949). From a distance, the chorus sounds like young crows calling. Eggs are laid in irregular bands on leaves and stems.

## Spotted Turtle

*Clemmys guttata* (Schneider)

Testudines: Emydidae

*Courtesy Jerry Czech*

Carapace (shell) about 3.5–4.5 inches (9–11 cm) long, broad, smooth, black, with distinctive but variable polka-dot pattern of up to 100 yellow spots.

The spotted turtle ranges from Maine and southern Ontario south to Florida and west through New York, Pennsylvania, Ohio, Indiana, and Michigan, to northeastern Illinois. It is a bog relict and has been the subject of much concern as its populations continue to decline due to pollution, habitat loss, and uncontrolled collecting. In Albany County, it is rarely found outside the Pine Bush. Stewart and Rossi (1981) reported the spotted turtle from the Pine Bush for the first time since Eights (1836) found it to be common here. The range of this species projects up the Hudson Valley from the more southern main body of the North American distribution. Spotted turtles occupy shallow wetland habitats with soft substrates and some vegetation, including swamps, bogs, marshes, and woodland streams. They are daylight creatures, and they are often found basking singly or in groups. These shy creatures hide and rest burrowed into wetland mud, in mammal burrows, or under vegetation. They are most active in cooler parts of the year, in spring and autumn. They congregate to hibernate underwater in mud and mammal burrows. The turtles mate in spring, and they nest in late spring and early summer in well-drained areas exposed to full sunlight, such as grass tussocks and hummocks of

moist sphagnum moss. One or two clutches of one to eight eggs each are produced from May to July. Eggs incubated at 72.5–80.6° F (22.5–27.0° C) produce mostly males; those incubated at 86° F (30° C) produce only females. Spotted turtles have been known to live more than 30 years in the wild. They feed in the water on both plant and animal matter, including carrion.

*John Sohlden/Visuals Unlimited*

## Wood Turtle

*Clemmys insculpta* (LeConte)
Testudines: Emydidae

Carapace (shell) about 5.5–8.0 inches (14–20 cm) long, very rough, sculptured; neck and limbs tinged orange.

The wood turtle occurs in a relatively small area of southeastern Canada and the northeastern United States. It occurs across most of New York State, but it has not been seen in the Pine Bush since the early 1980s, and perhaps it was never common here. The deep pools in streams that it prefers for winter hibernation are not common here. In April and May, wood turtles are mostly aquatic because of their preference for mating underwater. From June until autumn, they are more terrestrial. They are usually found in association with water, often in woodland openings near streams. They are also found in swamps, bogs, meadows, and pastures. These reptiles are diurnal. They are active during daylight, and at night they take shelter in water or in soil under grass, leaves, or brush. Mating occurs in water throughout the year, peaking in spring and fall. Nesting takes place in late spring and early summer in well-drained sights exposed to direct sunlight. A single clutch of 4–18 eggs is produced during the season. The eggs and shallow nest are covered with soil. Individuals have been known to live for more than 33 years in the wild. Wood turtles are omnivores, and a typical diet might consist of foliage, fungi, invertebrates, flowers, and fruits. They have been known to engage in a remarkable feeding behavior known as "worm stomping," in which the turtle slowly stomps on the ground and causes earthworms to surface (Ernst et al. 1994). Overcollecting and habitat destruction are major causes of population decline.

## Eastern Box Turtle

*Terrapene carolina carolina* (Linnaeus)
Testudines: Emydidae

Carapace (shell) 4.5–6.0 inches (11–15 cm) long, high, domelike, variable in color, usually with a variable yellow or orange pattern of radiating lines or spots on each pleural and vertebral scute; plastron (lower shell) consisting of two movable, hinged lobes; each hind foot with four toes.

Early in the 19th century, the eastern box turtle was a common sight in the Pine Bush. It was rediscovered here 20 years ago (Stewart and Rossi 1981) but has not been found since then. Recent attempts to reintroduce box turtles have been abandoned because of the tendency of relocated adults to wander extensively. The range of this turtle projects up the Hudson Valley from the more southern main body of the North American distribution, which extends to Geor-

gia and Tennessee. The species is characteristic of the open woodlands of dry pine–northern hardwood communities (Reschke 1990). Box turtles are terrestrial creatures, and the two lobes of the underplate, or plastron, can be drawn up tight against the carapace in front and rear for protection. They sometimes lounge in mud or water, and during hot, dry spells they seek such moist spots or they become inactive. To hibernate, they burrow, often shallowly, into the ground or pond mud, or they use mammal burrows. They are omnivores, consuming all kinds of plant and animal material, including carrion. Mating begins in the spring and lasts into the autumn. Nesting occurs in late spring and early summer, usually in an elevated patch of sandy soil or an open area. Four or five eggs are laid in an excavation and then covered with soil and vegetation. Egg clutches incubated at temperatures below 80.6° F (27° C) produce mostly males, while those incubated above 83.3° F (28.5° C) produce almost all females (Ernst et al. 1994). Individuals have been known to live for 138 years in the wild, although 30–40 years is probably average longevity.

*Bill Beatty/Visuals Unlimited*

## Eastern Worm Snake

*Carphophis amoenus amoenus* (Say)
Squamata (Serpentes): Colubridae

About 7.5–11.0 inches (19–28 cm) long, brown above, pink below, unpatterned, earthworm-like.

The eastern worm snake ranges from southeastern New England and adjacent New York south to South Carolina and northern Georgia and west to eastern Oklahoma and Kansas. Until recently a population of worm snakes was isolated in the Albany Pine Bush, separated from the main body of the species' North American distribution. Through the 1970s, individuals were rarely, if ever, found in Albany County outside the Pine Bush. In recent years they have not been found here either (Hunsinger 1999). The snakes might still be present, but they are very hard to find. In fact, since 1990 the eastern worm snake has not been found in New York State north of Putnam County, but it is common in the New Jersey Pine Barrens. The snakes prefer moist, rocky woodlands. These secretive reptiles are usually discovered by overturning boards, rocks, or other debris, or by pulling apart decaying tree trunks. During dry weather they burrow deep into moist soils and are rarely seen. The fossorial (burrowing) lifestyle helps *Carphophis* escape overheating or desiccation. The narrow head, cylindrical body, small eyes, smooth scales, and short tail facilitate burrowing. In June and early July, females typically lay two to five eggs in a clutch in depressions under rocks or inside rotting logs. Eggs hatch in August or September. Eastern worm snakes eat mostly earthworms, but they also take other soft-bodied, narrow, elongated prey. When handled, these shy creatures seldom, if ever, bite, but they do emit a rather pungent musk.

*A. B. Sheldon Nature Photography*

## Northern Black Racer

*Coluber constrictor constrictor* Linnaeus
Squamata (Serpentes): Colubridae

About 3–5 feet (0.9–1.5 m) long, slender, plain shiny black above and below.

The northern black racer occurs from southern Maine and central New York south to northern Georgia and Alabama. In New York State, the range of this species projects up the Hudson Valley from the more southern main body of its distribution. In Albany County, the black racer is rarely found outside the Pine Bush, and it might be extirpated from the Pine Bush as well (Hunsinger 1999). This species occurs in a variety of habitats, including woodlands, dry fields, and marshes, and individuals are often found basking, commonly on low branches. Females lay 9–12 eggs per clutch in June and July in such places as mammal burrows and rotting logs. *C. constrictor* eats many different kinds of animals and seems to show little preference, being an opportunistic predator. It is also cannibalistic, feeding on young of its own species. Despite its scientific name, it does not constrict its prey, but rather pursues and seizes it. The snakes move fast, often with their heads raised off the ground. When disturbed, they coil, vibrate their tails, and bite viciously. Black racers display a foul, nervous disposition, and they spray musk when handled.

## Eastern Hognose Snake

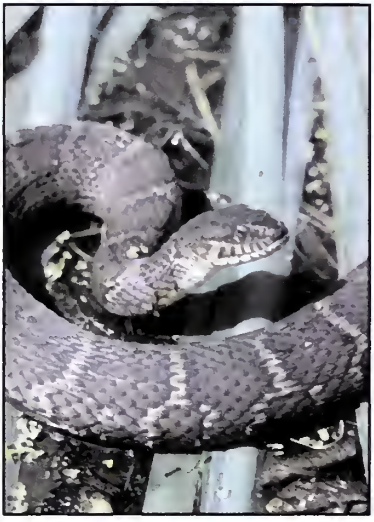
*Heterodon platirhinos* Latreille
Squamata (Serpentes): Colubridae

About 20–30 inches (51–76 cm) long; body thick and heavy; snout keeled and upturned; scales keeled; color variable, yellow to black, usually spotted.

*Courtesy Paul E. Meyers*

This species ranges up the Hudson Valley from the more southern main body of its distribution, which extends from southern New England south through Florida and west to Texas and Minnesota. In Albany County, it is rarely, if ever, found outside the sandy Pine Bush habitat, which is ideal for hognose snakes. They were found here early in the 19th century (Eights 1835, 1836). The area of Pine Bush occupied by Crossgates Mall was at one time home to a dense population of hognose snakes. The snakes fed on toads that bred in a pond on the site of the Mall (Stewart and Ricci 1988). When disturbed, these remarkable creatures display frightening hostility by flattening and spreading out their heads and necks, hissing, and inflating their bodies. In reality, these spreading, puffing, and hissing snakes are quite harmless. Further provocation may cause them to roll over and play dead. In a study of one adult female from the Pine Bush, it was found that the snake covered a 57- to 64-acre (23- to 26-ha) area each year, using only part of the area at a time before moving on to the next area (Hunsinger 1998). Hognose snakes are often found on open ground, prowling for prey. Like garter snakes, they feed mainly on toads, but they also take frogs, small mammals, salamanders, and other prey items. Competition for food might limit

hognose populations in the Pine Bush. Their saliva has mildly toxic properties and can cause burning pain and swelling. When not foraging, hognose snakes burrow into loose soil or hide among leaf litter. Eggs are laid in June and early July in loose soil or under debris, and hatchlings are found in August or early September.



*Courtesy Paul E. Meyers*

## Northern Water Snake

*Nerodia sipedon sipedon* (Linnaeus)
Squamata (Serpentes): Colubridae

About 2.0–3.5 feet (0.6–1.1 m) long, stout and heavy bodied, extremely variable in color and pattern, but usually tan to gray with wide brown or reddish brown crossbands alternating with dark square blotches along the sides. Readily recognized as the only large water snake in New York State.

The northern water snake occurs from extreme southern Ontario, Quebec, and Maine south to South Carolina, Georgia, and Alabama, and west to northeastern Oklahoma, eastern Colorado, and Nebraska. It is the only water snake in the Pine Bush. It also occurs in Albany County outside the Pine Bush, and it is found in most areas of New York State except for the far northern reaches. This reptile is found wherever abundant food, good cover, and quiet waters are found. The water snake is a good swimmer, passing through water with only its head above the surface. It can forage underwater and remain submerged for long periods. Females bear litters of 20 or more live young from mid August to late September. Over half the water snake's diet consists of fish, and *N. sipedon* has been known to prey on more than 30 different species of fish. The snakes supplement their diets with frogs and toads, salamanders, small mammals, worms, mollusks, insects, and other invertebrates. They are not venomous, but they have a vile temper and will bite and spread a horrendous musk.

*Arthur Morris/Visuals Unlimited*

## Whip-poor-will

*Caprimulgus vociferus* Wilson

Caprimulgiformes: Caprimulgidae

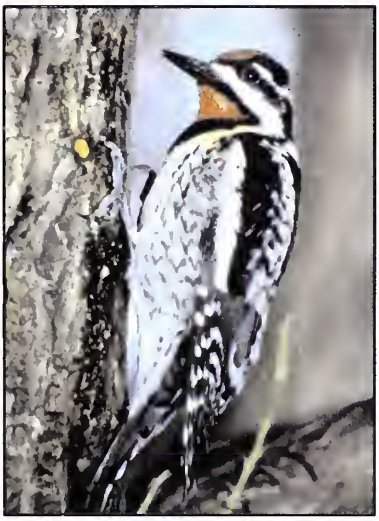
About 9.5 inches (24 cm) long, brown and mottled, blending well with dead leaves; bill tiny; eyes large; face bristled; tail large; with white patches in male, duller in female; readily recognized by distinctive and repeated call in spring and summer, especially at dusk or just before dawn.

The whip-poor-will ranges from southeastern and south central Canada to Honduras, spending winters in the Gulf states and south. It is a summer resident of the Albany Pine Bush, and it probably breeds here. It was once abundant, but it is likely a rare occurrence now. The species is characteristic of the pitch pine–scrub oak community, and other dry and leafy woodlands. Whip-poor-wills build no nests. They place eggs on a bed of leaves on the ground under overhanging branches in open woodland without dense underbrush. They feed largely on moths, especially large saturniid or silk moths, which they capture in mid-flight at night. The birds hunt visually and are most active on bright, moonlit nights. Because they are active at night, they are seldom seen.

## Yellow-bellied Sapsucker

*Sphyrapicus varius* (Linnaeus)

Piciformes: Picidae

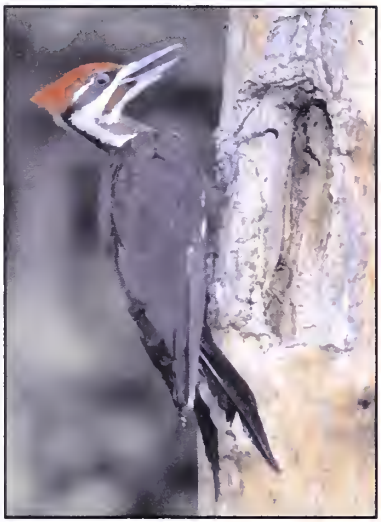


*W. Greene/VIREO*

About 8–9 inches (20–23 cm) long; a woodpecker with mostly black back and light yellowish underparts, white wing patch, red forehead patch; throat red in male, white in female.

The yellow-bellied sapsucker occurs in North and Central America, and it is commonly seen wintering in the southern United States, Central America, and the West Indies. It has been regarded as a spring and fall transient in the Albany Pine Bush, where it is near the southern edge of its breeding range and the northern edge of its winter range. However, it is also known to breed in the vicinity, and it may be only a matter of time before it is confirmed breeding in the Pine Bush. It is included in this field guide as an example of a bird characteristic of the successional hardwoods communities, especially mature aspen groves. If attempts to control aspen in the Pine Bush are successful, the yellow-bellied sapsucker could remain a rare occurrence. Nesting takes place within the forest, in dead or living trees with decaying heartwood, frequently mature aspen infected with fungus. The strong sapwood protects the nest. New nests are excavated each year, mostly by the male. Entrance holes are small, only about 1.5 inches (4 cm) in diameter. The birds

obtain sap by drilling rows of small holes in trees. They also consume some of the cambium layer of the tree and the insects that are attracted to the sap.



*Joe McDonald/Visuals Unlimited*

## Pileated Woodpecker

*Dryocopus pileatus* (Linnaeus)
Piciformes: Picidae

About 16.0–19.5 inches (41–50 cm) long., black. with a flaming-red crest.

The pileated woodpecker is resident year-round from Canada to the southern United States. It is a year-round resident of the Albany Pine Bush, and it probably breeds here. It is a characteristic species of pine–northern hardwood forests, but it also occurs in other communities, including deciduous forests, second-growth woods that have some large trees, and even in city parks where there are large trees. Pileated woodpeckers usually nest 8–70 feet (2.4–21.3 m) above ground in old and very large deciduous and coniferous trees, including pitch pine, and usually not far from water. They excavate new nest cavities each year in large dead trees, dead parts of living trees, or, rarely, in live wood. Nest trees are typically in shade in mature, dense forests. The woodpeckers also excavate characteristic, large oval, oblong, or almost rectangular holes while searching for tree-boring insects.

Downy and hairy woodpeckers (*Picoides pubescens* and *P. villosus*, respectively), which are smaller white and black species, are more commonly seen in the Pine Bush.

## Eastern Bluebird

*Sialia sialis* (Linnaeus)
Passeriformes: Muscicapidae (Turdidae)

*W. Greene/VIREO*

About 7 inches (18 cm) long, a little larger than a sparrow, appearing round shouldered when perched, blue with rusty red breast; female duller than male.

The eastern bluebird breeds from southern Canada south through the eastern United States, and it winters in the middle parts of the Untied States south to Mexico, the Gulf Coast, and southern Florida. The official state bird of New York, the eastern bluebird is a summer resident and confirmed breeder in the Pine Bush. Bluebirds start to arrive in New York State in late February and depart by late November. They typically inhabit open country with scattered trees. The bluebird is New York's only hole-nesting thrush. It nests in natural cavities in trees and stumps, and in artificial cavities of nest boxes and birdhouses, usually within a few feet of the ground, but sometimes as high as 35 feet (11 m) up in pitch pines. Nests are loose cups of grasses and stalks lined with finer pine needles, fine twigs, hair, and feathers. Bluebird numbers in New York State were on the decline since the early 1900s due to effects of harsh weather, reforestation, decrease in available nest sites, and increasing numbers of introduced European starlings and house sparrows that usurp nest holes,

and possibly pesticides. However, in 1951 the species was still common in the Albany Pine Bush (Treacy 1953). By 1981 Kerlinger and Doremus (1981b) reported that there was no evidence that the eastern bluebird continued to breed in the Albany Pine Bush. A 1981wildfire opened overgrown areas previously unsuitable for bluebirds. Efforts to provide artificial nest cavities by placing nest boxes in open habitats further helped to reverse the decline in Pine Bush bluebird numbers (Schroeder 1980, 1986). By 2001 Beachy (2002) was able to confidently report that this species is breeding in the Pine Bush. Adults were observed with juveniles. The eastern bluebird is known as a fire follower. Open areas that require recurrent fire for maintenance are natural bluebird habitat. Prescribed fire is usually beneficial to eastern bluebirds, especially if it controls shrubs and understory hardwoods. As with other thrushes, diet consists of insects, worms, snails, berries, and fruits.

*A. & E. Morris/VIREO*

## Brown Thrasher

*Toxostoma rufum* (Linnaeus)
Passeriformes: Mimidae

About 11.5 feet (29 cm) long, reddish-brown above, heavily striped below; beak decurved; eyes yellow; wings with double, light-colored bars; tail long.

The brown thrasher ranges east of the Rockies, from southern Canada to the Gulf states. It is a Pine Bush summer resident and confirmed breeder, typically found in the pitch pine–scrub oak barrens. Individuals usually arrive in late April and remain until early November. The species typically inhabits dry, open country at low elevations. Brown thrashers usually nest close to, or on, the ground, using twigs, stalks, leaves, grasses, and roots in nest construction. They are named for their habit of thrashing noisily in thick undergrowth, and they are more readily heard than seen. Brown thrashers typically feed on insects and fruits.

## Golden-winged Warbler

*Vermivora chrysoptera* (Linnaeus)
Passeriformes: Emberizidae (Parulinae)

About 5.0–5.5 inches (13–14 cm) long, gray above, white below; forehead yellow; mask or ear patch black; throat black in male, gray in female; wing with yellow bars. The golden-winged warbler is readily distinguished as the only warbler with yellow wing bars and a black male or gray female throat.

This species breeds from southern Manitoba east to New Hampshire, and south through the Appalachian Mountains to northern Georgia. It winters from southern Mexico to northern South America. The golden-winged warbler is not a common bird, but it has been expanding its range in the Northeast for more than a century as large tracts of agricultural land have been abandoned and the landscape has undergone early secondary succession. The Albany Pine Bush is near the northeastern limit of its range. The

*Maslowski/Visuals Unlimited*

golden-winged warbler was previously recorded as a Pine Bush summer resident, but it was not observed by Beachy (2002) in 2001. It has been known to nest nearby in the Mohawk Valley and in dry, open oak-pine barrens in Oswego County. These birds nest in areas with scattered patches of grass, thick brush, and a few trees. The fairly loose and disorderly cup-shaped nest is constructed on the ground, at the base of a cluster of plant stems. The birds' thin, pointed bills are used for capturing insects.

Brewster's warbler, another summer visitor, is considered a hybrid form between the golden-winged warbler and the blue-winged warbler, *V. pinus* (Linnaeus). It has whitish underparts, a narrow black band (rather than a wide mask or ear patch) extending from the base of the bill through the eye region, and two white wing bars. Although the blue-winged warbler is not recorded in the Pine Bush bird list, it is known to occur in the vicinity.

*Rob & Ann Simpson*

## Nashville Warbler

*Vermivora ruficapilla* (Wilson)
Passeriformes: Emberizidae (Parulinae)

About 4.7 inches (12 cm) long, distinguished by white eye-ring in combination with yellow throat; head gray; back olive-green; underside yellow; wings lacking bars.

The eastern race of the Nashville warbler breeds from Saskatchewan east through southern Canada and south through the Great Lakes region into New England. It winters from central Mexico south through Belize. It is listed as a spring and fall transient in the Pine Bush, although it is a locally numerous breeder in the Adirondack and Catskill Mountains and in central New York. This warbler characteristically inhabits successional hardwood forests, including shrubland of alder, willow and birch thickets, old burns, cut-over areas, or successional old fields reverting either to aspen-cherry thickets or stands of gray birch. It also chooses edges of tamarack swamps or spruce-sphagnum bogs. Although Reschke (1990) cited the Nashville warbler as a bird characteristic of successional northern hardwood forests, it has never been recorded as a Pine Bush summer resident, and Beachy (2002) did not encounter this species in his 2001 survey, which included observation points in early successional aspen and black locust communities. Nests, which are built on the ground in moss or against shrub bases, are small cups of rootlets and fibers lined with hair. The birds consume mostly insects.

*Arthur Morris/Visuals Unlimited*

## Chestnut-sided Warbler

*Dendroica pensylvanica* (Linnaeus)
Passeriformes: Emberizidae (Parulinae)

About 4.5–5.5 inches (11–14 cm) long; beak thin and pointed; eyes surrounded by narrow, white ring; wings with pale yellow bars. The chestnut-sided warbler is readily identified in spring by its yellow crown and chestnut sides. In autumn it changes to yellow-green above and white below.

During the breeding season, the chestnut-sided warbler can be found from central Canada east to the Maritime Provinces, south through New England and the Great Lakes, and in the Appalachian Mountains to northern Georgia. It spends winters from central Mexico south through Central America. The chestnut-sided warbler is found in New York State from early May to early October. It inhabits low, second-growth deciduous woodland, open aspen-cherry growth of old burns, and edges of woods. In the Pine Bush, Beachy (2002) found them often associated with younger stands of black locusts and aspens. Except when singing high in trees, it spends most of its time in brushy habitat within a few feet of the ground. Nests are placed in vines, bracken ferns, low bushes, and saplings 1–6 feet (0.3–1.8 m) above the ground. They are loosely woven, thin cups made from strips of bark, shredded stems, grasses and plant down, and sometimes lined with fine grasses or hair. Like other warblers, this species tends to prefer insects.

## Pine Warbler

*Dendroica pinus* (Wilson)
Passeriformes: Emberizidae (Parulinae)

*Doug Wechsler/VIREO*

About 5.0–5.5 inches (13–14 cm) long; male with bright yellow breast and white wing bars, lacking conspicuous streaks, spots, or patches; female duller. This species is difficult to identify because it resembles many other warblers, even in breeding plumage, and because its songs are similar to those of worm-eating and yellow-rumped warblers and chipping sparrows.

The pine warbler's breeding range includes the northern Great Lakes region, New York and adjacent southern Canada, the area from central Maine and southeast New England through Pennsylvania west to Illinois, and the Gulf states to southern Florida. The winter range includes the western Gulf states. It seems that prior to the recent conservation efforts in the Pine Bush, the pine warbler became progressively scarcer as habitat shrunk. In 1954 at least a dozen pairs were found within 4 miles in the Pine Bush, and it was still present in the 1970s, but in the 1980s and 1990s it seems that the species no longer bred here (Bull 1974; Kerlinger and Doremus 1981b). However, many pine warblers were observed throughout the Preserve and throughout the breeding season in 2000 and 2001 (Beachy 2002). In the Pine Bush, this species is near the northeastern limit of its range. It is found exclusively in mature pine forests, and although its habitat can

include almost any species of pine, it is commonly found among pitch pines, and its nests may be found in the trees, 10–60 feet (3–18 m) above the ground. It is primarily a summer resident, and like other warblers, it feeds mainly on insects. The rare individuals that remain into fall or winter consume seeds, fruits, and berries.

*Rob & Ann Simpson*

## Prairie Warbler

*Dendroica discolor* (Vieillot)
Passeriformes: Emberizidae (Parulinae)

About 5 inches (13 cm) long; underparts yellow, with black stripes confined to sides; face with one black streak extending from bill through eye, and another black streak below; male with chestnut marks on back. This species and the palm warbler bob their tails. Its characteristic song is a thin, buzzy crescendo *zee zee zee zee zee zee zee zee*.

The northern boundary of the prairie warbler's eastern United States breeding range includes southern New England, New Jersey, southern Pennsylvania and Ohio, Indiana and Illinois, and southern Missouri. Scattered populations breed north of the primary breeding range to Michigan and southern Ontario. The prairie warbler winters mainly in the West Indies, and also in southern Florida. It deserves equal billing with the Karner blue butterfly and inland barrens buck moth as a characteristic Albany Pine Bush species. It is a common summer resident, arriving by late May and departing in August. In the Pine Bush, it is close to the northern limit of its breeding range. Its narrow habitat requirements restrict it not to prairie, but to open dune formations where pitch pines are few and scrub oaks and dwarf chestnut oaks dominate the landscape. It prefers bushy clearings and fields subject to frequent fires. The prairie warbler avoids areas in which the oaks and pines have become overgrown. It nests during June and July in the low trees and shrubs on burned-over areas of the Pine Bush. Nests are attached to forks in branches 1–10 feet (0.3–3.0 m) above the ground. They are compact, thick walled, and firmly woven from plant down, bark shreds, straw, and dry leaves. Nests are bound with spider silk and lined with hair and feathers. Males sing and proclaim their territory from the widely spaced pitch pine trees.

*Maslowski/Visuals Unlimited*

## Ovenbird

*Seiurus aurocapillus* (Linnaeus)
Passeriformes: Emberizidae (Parulinae)

About 6 inches (15 cm) long, thrush-like; crown with orange area bordered by dark bands; back olive-brown; underside white with streaks of dark spots. The ovenbird is more often heard than seen. Its song, an emphatic "teach" or "teacher," is rapidly repeated in rising volume.

The ovenbird breeds in southern Canada and the United States east of the Rockies and south to northern Georgia, Arkansas, and Oklahoma, with scattered populations to the west. It winters in Mexico, Central America, and the Caribbean. This species is a breeding summer resident in the Pine Bush. It is one of the five most abundant birds in the New Jersey Pine Barrens, although it seems to be a little less abundant here. Ovenbirds are usually found in open forests with an abundance of fallen leaves and logs, such as the pitch pine–scrub oak community. They can be seen walking on pale pinkish legs on the ground among scrub, tail cocked. The nest, built among dead leaves on the ground, has an arched top of dead leaves and resembles a Dutch oven. Nests are often parasitized by brown-headed cowbirds.

## Common Yellowthroat

*Geothlypis trichas* (Linnaeus)
Passeriformes: Emberizidae (Parulinae)

About 4.5–5.5 inches (11–14 cm) long, wren-like; male readily identified by black mask and yellow throat; females olive brown with yellow throat.

The common yellowthroat breeds throughout most of North and winters in the southern United States, Mexico, Central America, and the West Indies. In the Pine Bush, it is a common summer resident and confirmed breeder, typically found in the pitch pine–scrub oak barrens. It typically inhabits shrubs and thickets in moist or wet situations, but it is no stranger to dry hillsides. It normally nests within a few inches of the ground. The concealed nests, consisting of loosely woven vegetation and attached to tussocks, shrubs, or other vegetation, are often host to eggs of the brown-headed cowbird. Like other warblers, the common yellowthroat tends to prefer insects.

*Lang Elliott/Cornell Laboratory of Ornithology*

*Doug Wechsler/VIREO*

## Eastern Towhee

*Pipilo erythrophthalmus* (Linnaeus)

Passeriformes: Emberizidae (Emberizinae)

About 7.5–8.0 inches (19–20 cm) long, readily recognized by the robin-red sides; head and upper parts black in male, brown in female; belly white; corners of tail with white patches.

The eastern towhee breeds throughout the eastern United States, wintering in the southeastern and south-central states. At one time it was considered the same as the more western spotted towhee (*Pipilo maculatus* Swainson), and both were collectively known as the rufous-sided towhee. In New York State, the eastern towhee breeds in all but the mountainous areas of northern New York, and it is particularly abundant in pitch pine–scrub oak barrens. This common species is perhaps the most abundant bird at the Albany Pine Bush, Long Island barrens, and New Jersey Pine Barrens. In the Albany Pine Bush, it is a common summer resident and confirmed breeder characteristic of the pitch pine–scrub oak community. The birds require dense, brushy cover, and visitors often hear them rummaging noisily among dead leaves. They search the soil for insects and other invertebrates, as well as seeds and berries, with a characteristic "double-scratch" behavior. They make a short jump forward and then scratch back with both feet at once to uncover food. Migrant towhees arrive in the Pine Bush early April and depart by the middle of November. Females construct cuplike nests from leaves, stems, strips of bark, and grass, and they line them with finer materials. Typically nests are on or close to the ground under a bush or brush pile or a clump of grass. They are so well camouflaged that the incubating female will often sit tight until almost stepped on by passersby. Nests are frequently parasitized by brown-headed cowbirds.

## Field Sparrow

*Spizella pusilla* (Wilson)

Passeriformes: Emberizidae (Emberizinae)

About 5 inches (13 cm) long; bill pink; cap rusty; eye surrounded by narrow, light colored ring; facial striping less noticeable than in other rusty-capped sparrows.

Field sparrows breed from New Hampshire to eastern Montana and south to northeastern Texas to Georgia. They are common Pine Bush summer residents and confirmed breeders, occurring in brush and scrub. Females construct nests a few inches above the ground in thick tangles among shrubs and grasses of fairly open country. Nests are woven of grass roots and stems and lined with finer grasses and hairs. The small but stout, canary-like bills are adapted for seed cracking. Field sparrows also consume insects and fruits. Both males and females feed the young. Two or three broods are produced each year.

*A. Morris/VIREO*

*K. Maslowski/Visuals Unlimited*

## Indigo Bunting

*Passerina cyanea* (Linnaeus)

Passeriformes: Emberizidae (Cardinalinae)

About 5.5 inches (14 cm) long; male deep, brilliant blue all over, becoming more brown, like the female, in autumn; wings without bars.

Indigo buntings breed in the eastern United States and spend the winter in Florida, Mexico, Central America, and the Caribbean. They are Pine Bush summer residents and confirmed breeders. Their bright color and habit of singing their lively song from exposed perches make them conspicuous birds. This widespread and common species is characteristic of the pitch pine–scrub oak barrens and other open habitats that provide dense cover for nesting and tall trees for song perches. Nests are sited about 2–4 feet (0.6–1.2 m) above the ground in saplings and bushes. Females carefully weave the small, cup-shaped structures from dried grasses, leaves, and strips of bark. They line the cups with fine grasses, feathers, and hairs. Brown-headed cowbirds often parasitize the nests. The birds' small but stout, canary-like bills are adapted for seed cracking. Indigo buntings also consume insects and fruits.

## Brown-headed Cowbird

*Molothrus ater* (Boddaert)

Passeriformes: Emberizidae (Icterinae)

*William J. Weber/Visuals Unlimited*

About 7 inches (18 cm) long; male black with brown head; female gray; beak short, stout, finch-like.

The brown-headed cowbird breeding range extends from southeastern Alaska, through lower Canada and the continental United States to central Mexico. The winter range extends from New England, the Great Lakes states, southern Iowa, Kansas, Texas, southern New Mexico and Arizona, and northern California south to Oaxaca and northern Baja California. The brown-headed cowbird breeds at low elevations throughout New York State. It is also known to winter throughout the state and is a frequent visitor to winter feeding stations. It is a common Pine Bush resident, typically found in the pitch pine–scrub oak barrens and in areas invaded by aspen and black locust trees (Beachy 2002). It usually avoids deep forests, but it enters wooded areas to lay eggs in nests of woodland-dwelling birds. Forest fragmentation could perhaps enable this edge species to easily find host nests. Eastern towhee, prairie warbler, ovenbird, pine warbler, and brown thrasher, the five most characteristic pine barrens birds, are all known hosts of the brown-headed cowbird in New York State. Females lay eggs in nests of at least 77 other species in New York, mostly warblers, finches, and sparrows, and especially the yellow warbler, red-eyed vireo, and song sparrow. The host raises and cares for the cowbird young at the expense of its own. The brown-headed cowbird could be a significant factor in reducing populations of breeding birds, but it is unclear how they are affecting bird populations in the Albany Pine Bush. Cowbirds often follow other animals, looking for insects driven from the grass as the animals feed.

*Gary Meszaros/Visuals Unlimited*

## Masked Shrew

*Sorex cinereus* Kerr

Insectivora: Soricidae

About 3.5 inches (9 cm) from snout to tip of tail; face lacking an obvious mask; snout long, slender, conical; head and body about 2.0–2.5 inches (5–6 cm) long, grayish brown above, paler underneath; tail about 1.2 inches (3 cm) long, bicolored, lighter below.

The masked shrew occurs throughout most of Canada, Alaska, and the northern United States in moist areas of forests, brushland, and open country. It is most common in moist deciduous or coniferous sites near streams, ponds, marshes, or bogs. It also occurs in open areas if humidity is high, but tends to avoid dry or barren sites. Masked shrews remain active throughout the year; they do not hibernate. They burrow through snow and are sometimes seen scampering across tops of snowdrifts. Because of their high metabolism, masked shrews require food frequently. Favorite foods include beetles, flies, ants, crickets, grasshoppers, spiders, and moths, which they find by burrowing through loose soil or grass, leaves, and other material above ground. Masked shrews breed from April to October. The young are capable of breeding in their second year. Females produce two to three litters per year, each consisting of 4–10 young. They nest in cavities of tree stumps, in fallen logs, in their own burrows or those of other mammals, or under rocks or other materials.

## Hairy-tailed Mole

*Parascalops breweri* (Bachman)

Insectivora: Talpidae

*Bill Beatty/Visuals Unlimited*

About 5.5 inches (14 cm) from snout to tip of tail; head and body about 4.5–5.5 inches (11.5–14.0 cm) long, with slate gray fur; eyes small, barely functional, hidden in fur; forelimbs enlarged, turned outward, armed with large claws for digging; tail only about 1 inch (2.5 cm) long, distinctly haired. This is the smallest of eastern moles, and the only one with a short, hairy tail.

The hairy-tailed mole occurs in southeastern Canada, New England, New York, Pennsylvania, West Virginia, and surrounding areas. It is found in shrubby areas and forests on well-drained sandy loam. Individuals can be active day or night. Like other moles, they are highly modified for a burrowing existence. They often leave their tunnels at night to feed on the forest floor. Contrary to rumor, moles do not eat roots or vegetables. They feed strictly on insects and worms. They often tunnel under turf in search of grubs. Moles have only one litter per year, in April or May, and it consists of four to five young. Deep tunnels,

down to about 2 feet (0.6 m) below the soil surface, are occupied in the winter. Nests about 6 feet (15 cm) in diameter, constructed of dead leaves, are found in these lower strata.

The distinctive star-nosed mole has 22 short, fleshy tentacles surrounding its nose. This semiaquatic species prefers low, wet ground near lakes and streams.

*Courtesy Paul E. Meyers*

## Eastern Chipmunk

*Tamias striatus* (Linnaeus)
Rodentia: Sciuridae

About 9.5 inches (24 cm) long from snout to tip of tail; head and body about 5–6 inches (13–15 cm) long; ears prominent; back with five black, longitudinal stripes; light stripes situated between the pairs of lateral black stripes; body otherwise yellowish to reddish brown; tail about 3.3 inches (8.4 cm) long, well-haired, held erect while running.

Eastern chipmunks occur in southeastern Canada and the eastern United States, where they inhabit primarily open deciduous forests and brushy areas. They are common in the Pine Bush and often seen on the ground among brushy vegetation. Their sharp *chip chip chip* call is commonly heard throughout the Pine Bush. Other vocalizations include a familiar high *chip*, a series of closely spaced chips, and a low *cuk*. These small, solitary squirrels are active during daylight hours. They live primarily on the ground, although they are frequently seen in trees. They dig burrows in the ground and scatter the evidence of their excavations. Simple burrows are temporary shelter and may be made by young individuals. More extensive burrows have up to five entrances, 100 feet (30 m) of tunnels 2–3 feet (0.6–0.9 m) below ground, a nesting chamber with a leafy nest, and three storage chambers. Usually only one adult chipmunk occupies a tunnel system, often with young. Mating usually takes place in early spring, and three to five young are born before summer. Chipmunks consume mostly nuts, but they also eat fruits, seeds, bulbs, insects, meat, eggs, and fungi. In late summer and early fall, they are busy gathering and storing food, primarily acorns and hickory nuts, for the winter. They can be seen the Pine Bush scurrying up and down oaks gathering acorns. They awaken several times from hibernation to eat, and they sometimes come aboveground in the middle of winter.

Other Pine Bush squirrels include the eastern gray squirrel, red squirrel, and southern flying squirrel. The gray squirrel, which is large and has a very bushy tail, prefers river bottoms and hardwood forests with oaks and nut trees. The red squirrel is about half the size of the gray squirrel and is often recognized by its nervous scampering, noisy habits, and rolling chatter. It prefers pine or mixed hardwood forests. The seldom-seen flying squirrel is small and nocturnal. These three squirrels nest in tree holes or make leaf nests in trees. The related woodchuck digs extensive underground burrows and feeds in fields, forest edges, and vegetable gardens.

*Rob & Ann Simpson*

## Woodland Jumping Mouse

*Napaeozapus insignis* (Miller)
Rodentia: Dipodidae (Zapodinae)

About 9 inches (23 cm) from snout to tip of tail; head and body about 3.5–4.0 inches (9–10 cm) long; body brown above, yellowish brown on sides, white below; hind feet large, white; tail very long, about 5 inches (13 cm), bicolored, dark brown above, creamy white below, with white tip.

*Napaeozapus insignis* is found in southeastern Canada from Labrador to Manitoba. In the United States it ranges from Maine to northeastern Minnesota, south to West Virginia, and the along the Appalachian Mountains to northern Georgia. Woodland jumping mice have been observed leaping 8–12 feet (2.4–3.7 m). They prefer cool, damp, forested or brushy areas and meadows, bogs, and stream banks. These primarily nocturnal rodents feed on seeds, fruits, subterranean fungi, and insects. For shelter, they sometimes use burrows of other animals, or they retreat to rotting logs or fallen trees. Nests are placed well below ground surface. One litter of three to six young is produced in June or July, and perhaps another in August or September. Woodland jumping mice hibernate through the winter.

A related species, the meadow jumping mouse, *Zapus hudsonius* (Zimmermann), prefers grassy areas and is extremely rare in the Albany Pine Bush. It lacks the white tail tip.

## Southern Red-backed Vole

*Clethrionomys gapperi* (Vigors)
Rodentia: Muridae (Arvicolinae)

*Courtesy Paul E. Meyers*

About 5–7 inches (12–17 cm) from snout to tip of tail; head and body about 3.5– 4.5 inches (9–11 cm) long, usually reddish brown or rust colored above, duller on the sides, gray below; eyes small; ears not prominent; tail short, about 1.5 inches (3.8 cm) long.

Southern red-backed voles, also known as boreal red-backed voles, occur across the entire southern tier of Canadian provinces, the northern United States, and farther south in the Rockies and Appalachians. They typically inhabit cool, shaded woods and cold, isolated mountaintops and sphagnum bogs, and they can be incredibly abundant in the Adirondacks. In the Albany Pine Bush, they are found in the forested ravines, where they have probably thrived for a very long time. It is unlikely that they crossed surrounding developed areas in order to reach the Pine Bush. These voles run about freely throughout the day and night under the cover of leaf litter, and they are also agile climbers. They do not tunnel or clear trails, but they are known to use tunnels of other animals as nesting sites. They also nest under roots and logs. Several litters of two to eight young are produced late winter to late fall. Males remain with females until the young are grown. Southern red-backed voles consume berries (especially blueberries), nuts, and seeds. Fungi, especially hypogeous species adapted to fruit underground, are also a very important source of nutrition (Haines et al. 1990). Insects are rarely eaten.

The related meadow vole or field mouse, *Microtus pennsylvanicus*, is dark brown, and it occurs in low, moist, and grassy situations, which are not common in the Albany Pine Bush. These voles construct systems of surface runways or trails through grass and under snow. The runways become evident after snow melts in the spring. These prolific creatures feed on pitch pine seedlings, and they are an important food source for many predators, including the short-tailed weasel.

*Courtesy Paul E. Meyers*

## White-footed Mouse

*Peromyscus leucopus* (Rafinesque)
Rodentia: Muridae (Sigmodontinae)

Length 6–8 inches (15–21 cm) from snout to tip of tail; head and body about 3.5–4.5 inches (9–11 cm) long; grayish-brown to reddish-brown above; belly and feet white; tail 2.5–3.7 inches (7–10 cm) long, shorter than head and body, lacking prominent tuft of hairs at tip. The white-footed mouse is similar to the woodland deer mouse (*P. maniculatus*) and difficult to distinguish from it. Its tail is usually slightly shorter than the length of the head and body.

The white-footed mouse is widely distributed in the United States east of the Rocky Mountains, where it occurs mostly at forest edges and in brushy areas. Its large eyes and big ears assist in its nocturnal activities. This species is semiarboreal and often nests in tree holes and old stumps, abandoned bird and squirrel nests, in underground tunnels, dense piles of debris, and similar places. The mice breed primarily in late spring and early autumn, and they produce four to five young in each of several litters per year. Individuals live up to 3 years in the wild. Populations sometimes reach very high levels. Individuals are normally active throughout the winter, although some hibernate. They are known to nest communally in winter. They consume great quantities of caterpillars, beetles, and other insects in summer. Fall and winter foods include nuts, berries, and seeds. Blueberries, huckleberries, black cherry seeds, and pine seeds are favorites. Nonhibernating mice store large quantities of food for winter, including cherry pits, hickory nuts, acorns, conifer seeds, and other items. The large Pine Bush population of white-footed mice accounts for the occurrence of many other animals that rely on mice for their sustenance. Foxes, weasels, hawks, and owls prey heavily on white-footed mice, field mice, deer mice, red-backed voles, and house mice. The white-footed mouse is a primary host for larvae and nymphs of the tick that carries Lyme disease.

The very similar and closely related woodland deer mouse is usually less apt to spend its time at or near ground level.

*Dwight Kuhn Photography*

## Woodland Deer Mouse

*Peromyscus maniculatus* (Wagner)
Rodentia: Muridae (Sigmodontinae)

Length 5–9 inches (12–23 cm) from snout to tip of tail; head and body about 3–4 inches (7.6–10.2 cm) long, pale grayish buff to deep reddish brown above, white below; feet white; tail always sharply bicolored, white below, dark above, about 2–5 inches (5–13 cm) long. The woodland deer mouse is similar to the white-footed mouse and difficult to distinguish from it. Its tail usually is not shorter than the length of the head and body.

Deer mice are widely distributed across North America and occur in all kinds of dry, upland habitats, including forests, scrubland, and grassland. They are often the first mammals to invade an area that has been burned. Habitat preferences become apparent at the subspecies level, and it is likely that some deer mouse subspecies replace other subspecies over the course of succession. Deer mice are nocturnal creatures, scurrying around at night and spending daylight hours in permanent nests or temporary shelters in the ground, in trees, or in buildings. They produce two to four litters per year, each with three to five young. Breeding occurs from early spring to late fall. Woodland deer mice do not hibernate, but they are known to nest communally in the winter, when they draw upon a store of nuts and seeds that they collect in summer and fall. They also consume berries and insects, especially caterpillars and large beetles. Deer mice are capable of causing substantial loss of tree seed crops. In the wild, they rarely live more than 2 years. Deer mice are prey to a number of mammals, birds, and snakes.

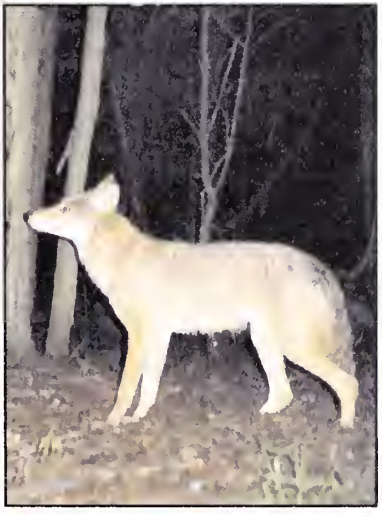
The very similar and closely related white-footed mouse is usually more apt to spend its time at or near ground level. Its tail is usually slightly shorter than half the total length of an individual and tends to be less distinctly bicolored. However, these morphological traits fail to distinguish the two subspecies that occur in eastern New York. Genetic tests are needed for positive identification.

## Coyote

*Canis latrans* (Say)
Carnivora: Canidae

About the size of a medium dog, 41–52 inches (105–132 cm) from snout to tip of tail; superficially similar to a German shepherd or husky; head and body gray or reddish gray, white underneath; legs, feet, and ears rusty; tail 12–15 inches (30–39 cm) long, bushy, black-tipped, and with elongate black mark above, near base. The red fox has a white-tipped tail and black feet. The gray fox has a black stripe down the top of the tail. Foxes hold their tails out straight and domestic dogs hold their tails up while running, whereas coyotes hold their tails down while running. Coyotes in eastern North America are on average larger than those from the West. In the Albany Pine Bush, three adult females averaged 34 pounds (15.5 kg), and one adult male weighed 40 pounds (18 kg).

Coyotes now occur across North America from



*Roland Kays and Daniel Bogan*

Alaska to Panama, having made dramatic expansions in the last century from their original home on the western plains. They were not always residents of New York State and the Pine Bush. After the extirpation of the wolf from New York in the late 1800s, feral domestic dogs were nuisances until coyotes migrated into the state by crossing the St. Lawrence River from Ontario in the 1940s. Coyotes probably arrived in the Capital District in the 1950s, although they did not reach substantial densities until much later. By 2000 coyotes occupied nearly all of the wild land in the East, except for the preserves of Long Island. They are adaptable and tolerant of humans. The Albany Pine Bush offers them prime habitat.

*Canis* species are unusual among mammals in their ability to hybridize. When the first coyotes crossed into New York State about 60 years ago, their population was small. However, they mated with the plentiful feral domestic dogs (*C. familiaris*), producing coyote-dog hybrids commonly known as coydogs. Coydogs were a passing phenomenon. As the population of true coyotes increased, they scorned the advances of domestic dogs, and eventually killed them off throughout the state. Today packs of feral dogs menace people only in inner cities and on Long Island, where there is no competition from coyotes. Some scientists suggest that our present-day eastern coyotes maintain a genetic signature from an early hybridization with gray wolves (*Canis lupus*), contributing to their larger size. This hypothesis is controversial and remains unconfirmed.

There are probably two or three packs of coyotes in the Albany Pine Bush Preserve, with more around the periphery. Radio-tracking data show that these animals are using home ranges of approximately 2 square miles (5 sq km), smaller than any other eastern coyotes studied to date. Pine Bush coyotes feed predominately on eastern cottontails and white-tailed deer. Deer are eaten by coyotes mostly at the end of winter, when adults are weak, and in early summer, when fawns are vulnerable. Small mammals are taken throughout the year, and some fruits are eaten in the fall. Evidence of only one domestic cat was found in examination of more than 200 coyote fecal samples. These samples also revealed very little consumption of garbage, a surprising discovery, given the proximity of the Albany Landfill. These are important findings because they demonstrate that Pine Bush coyotes are not associating pets or trash with food. They are therefore unlikely to become a nuisance around homes. Radio-collared Pine Bush coyotes are rarely found near houses. They prefer the larger fragments of forest. They avoid crossing roads, and they almost never cross the larger highways. One animal was observed successfully crossing the New York State Thruway, but it was later found dead on the same highway (Bogan and Kays 2002).

Humans make life hard for coyotes in the Pine Bush. Of eight recorded deaths, four were caused by motor vehicles, three were caused by gunshots, and one was a case of poisoning. Nonetheless, coyotes are survivors. They persist in the Pine Bush, claiming their hunting grounds with their trademark yippy-howls on moonlit nights.

Roland Kays and Daniel Bogan

*Courtesy Paul E. Meyers*

## Red Fox

*Vulpes vulpes* (Linnaeus)
Carnivora: Canidae

About the size of a small dog, 38 inches (97 cm) from snout to tip of tail; head and body about 22–25 inches (56–64 cm) long, usually reddish yellow or sometimes darker above, white underneath; legs and feet black; tail about 14.5 inches (37 cm) long, bushy, white-tipped. The coyote and gray fox do not have white tail tips. Foxes hold their tails out straight when running, whereas coyotes hold their tails down while running.

The range of this species includes most of Canada and the United States, except for the far north and much of the far west. Recent studies have concluded that our North American red fox is the same species as the Old World red fox, although it had long been considered a separate species. It enjoys a diversity of habitats, including settled areas, but it prefers a mixture of forest and open country. Red foxes are most active between late evening and early morning, although it is not unusual to see them during the daytime, especially when their interest is peaked by diurnal prey, such as voles. They prey upon small animals, including insects, snakes, rodents, and birds, and they supplement their diet with carrion, acorns, fruit, and berries. They stalk their prey after homing in on it by listening for low-frequency noises generated by their digging, gnawing, and rustling through leaves. Prescribed fire that favors small mammals by enhancing forage and fruit production would probably maximize the abundance of food for red foxes. Foxes occupy small, vigorously defended territories of about 150–1,500 acres. They are not as good at defending themselves against coyotes as are gray foxes. This may be the reason why red foxes are now typically found only in smaller patches of forest and backyards, areas unlikely to be hunted by a coyote (R. Kays, personal communication). In January or February, as winter days become longer, they announce the mating season with nocturnal barking. It is thought that the male and female mate for the year, or perhaps permanently, and both participate in the feeding and care of the young, which are born in spring. Usually there are 4–10 young in a litter. They leave the den and begin independent life in the fall. Individuals live 3–7 years.

*Roland Kays and Daniel Bogan*

## Fisher

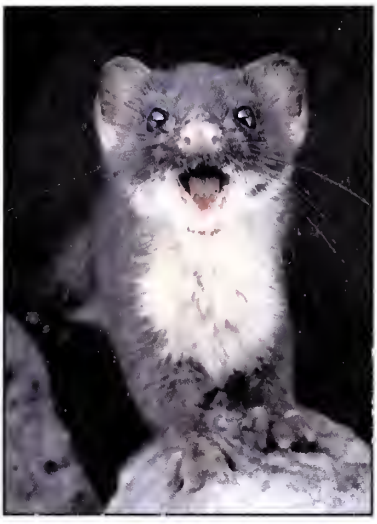
*Martes pennanti* (Erxleben)
Carnivora: Mustelidae

Large, stocky weasel-like animal, about the size of a fox; head and body 20–25 inches (51–63 cm); tail bushy, 13–15 inches (33–38 cm) long; total length of males 35–47 inches (90–120 cm), females 30–37 inches (75–95 cm); dark brown above and below, face, neck, and shoulders sometimes marked with hoary gold or silver guard hairs; throat and chest typically marked with white or cream patches of varying size and shape.

Today fishers occur across the southern tier of Canadian provinces and south into California, the Rocky Mountains, New England, and New York. Originally they occurred throughout the northern forests of the East and south through the Appalachians. The dark, luxurious pelts demanded such high prices that zealous trappers drove the animals to extinction in all but the wildest parts of the East. In 1624 the Dutch established Fort Orange as a fur-trading post in New Netherlands at the site of present-day Albany. It is probably safe to say that fishers were driven out of the area shortly thereafter. In New York State, fishers survived only in the Adirondacks. Today fur prices are floundering, and fishers have responded to reduced trapping by increasing in numbers and reclaiming their historic range. It was not surprising when researchers at the New York State Museum documented the presence of fisher in the Albany Pine Bush in the fall of 2000 with a motion-sensitive camera.

Fishers are predators of small and medium-sized animals, but they also feed on fruits and nuts. They are one of the few predators to regularly hunt porcupines, killing them with fast frontal attacks. Fishers typically hunt at night and spend most of the day in a tree-hole or appropriated squirrel nest, but they can be active any time of day. They normally avoid open habitats and human disturbance, but two radio-collared fishers in the Pine Bush were recently found in these types of areas. One animal even spent the day up a tree in the middle of a golf course. Despite these occasional wanderings through disturbed areas, Pine Bush fishers appear to prefer the larger forest fragments, and they rarely cross roads. Their speed, alertness, nocturnal hunts, and tree-nesting habits make them difficult to observe, but they travel long distances, and their tracks should be looked for in the snow—proof that they have reclaimed the Pine Bush as their rightful home.

Roland Kays and Daniel Bogan



*Rob & Ann Simpson*

## Long-tailed Weasel

*Mustela frenata* Lichtenstein
Carnivora: Mustelidae

Male about 16 inches (41 cm) long and female 12.5 inches (32 cm) long from snout to tip of tail; head and body about 9.0–10.5 inches (23–27 cm) long in male and 8–9 inches (20–23 cm) long in female; neck long; body long and slender, dark brown with yellowish white underparts in summer, white in winter; legs short; tail about 5.3 inches (13.5 cm) long in male and 4.3 inches (10.9 cm) long in female, with black tip in both summer and winter. The similar ermine, or short-tailed weasel, is smaller and has white feet. The mink is uniformly dark brown with a white chin patch.

The long-tailed weasel occurs in all kinds of land habitats near water throughout most of the United States, southern Canada, and south to South America. It is active day and night throughout the year, killing and consuming small mammals found in their burrows or runways, and also taking the occasional bird, snake, or insect. It nests in wood piles, stumps, hollow logs, and old burrows of other mammals. Nests consist of fur and cast-off parts of former prey. Adults mate in July or August, and young are born in April or May. They produce three vocalizations described as trills, screeches, and squeals.

# Appendices

# Appendix A

## Bryophyte Species List

Norton G. Miller and Lorinda Leonardi
New York State Museum

An inventory of Albany Pine Bush bryophytes began in the late 1800s with a few collections gathered incidental to other work by Charles Horton Peck, the New York State botanist at that time. Noteworthy collections were obtained in the mid-1900s by Stanley J. Smith (New York State Museum), Theodore C. Baim (Schenectady, New York), and Robert Dirig (Bailey Hortorium, Cornell University; see Dirig 1986a, 1986b). Our collections, mostly gathered in 1996 and 1999, came from three areas: north of the Guilderland Elementary School (Town of Guilderland), the headwaters of the Kaikout Kill and its tributary (City of Albany), and the Albany Pine Bush Preserve east of Karner Road (City of Albany). Our species list, with a few exceptions, is vouchered by specimens in the herbarium of the New York State Museum. Bracketed numbers indicate general habitat types in which species have been found:

[1] Pitch pine–oak forest, sandy soil or rotting logs
[2] Secondary deciduous forest; sandy soil
[3] Ravines of stream headwaters and tributaries; sandy soil, rotting logs, tree bark
[4] Streams; wet rocks
[5] Open fen wetlands; peat or in standing water
[6] Swales and ponds with high water tables; peat
[7] Wet thickets; muck, tree bark
[8] Hardwood swamps or wet forests; peaty or sandy soil or rotting logs
[9] Ponds
[10] Pond margins; sand or organic soil
[11] Epiphytes on tree bases and boles

Hornworts (1 species)
Phaeoceros laevis subsp. carolinianus (Michx.) Prosk. [1, 8]

Liverworts (20 species)
Aneura pinguis (L.) Dum. [3]
Calypogeia muelleriana (Schiffn.) K. Müll. [8]
Cephalozia connivens (Dicks.) Lindb. [6]
Cephaloziella hampeana (Nees) Schiffn. [1]
Conocephalum conicum (L.) Lindb. [3, 4, 6]
Frullania eboracensis Gott. [3, 6, 11]
Geocalyx graveolens (Schrad.) Nees [3]
Jungermannia leiantha Grolle [3]
Lejeunea ulicina (Taylor) Taylor [3]
Lophocolea heterophylla (Schrad.) Dum. [3, 6, 8]
Marchantia polymorpha L. [5]
Nowellia curvifolia (Dicks.) Mitt. [3, 6, 8]

Pallavicinia lyellii (Hook.) Carruth. [6, 8]
Pellia epiphylla (L.) Corda [3, 8]
Plagiochila asplenioides (L.) Dum.
Porella platyphylla (L.) Pfeiff. [3, 11]
Ptilidium pulcherrimum (G. Web.) Hampe [1, 6, 8, 11]
Riccardia latifrons Lindb. [8]
Riccia fluitans L. [9]
Ricciocarpos natans (L.) Corda [9]

Mosses (99 species)
Anomodon attenuatus (Hedw.) Hüb. [3, 11]
Atrichum altecristatum (Ren. & Card.) Smyth & Smyth
Atrichum angustatum (Brid.) Bruch & Schimp. in B.S.G. [1, 2, 3]
Atrichum oerstedianum (C. Müll.) Mitt. [3]
Atrichum undulatum (Hedw.) P. Beauv. [3]
Aulacomnium heterostichum (Hedw.) Bruch & Schimp. in B.S.G. [3]
Aulacomnium palustre (Hedw.) Schwaegr. [5, 7, 8]
Bartramia pomiformis Hedw. [3]
Brachythecium reflexum (Starke in Web. & Mohr) Schimp. in B.S.G. [2, 11]
Brachythecium rivulare Schimp. in B.S.G. [6]
Brachythecium rutabulum (Hedw.) Schimp. in B.S.G. [3]
Brachythecium salebrosum (Web. & Mohr) Schimp. in B.S.G. [1]
Brachythecium velutinum (Hedw.) Schimp. in B.S.G. [1]
Bryhnia novae-angliae (Sull. & Lesq. ex Sull.) Grout [3, 6]
Bryohaplocladium virginianum (Brid.) Wat. & Iwats. [1]
Bryum argenteum Hedw. [1, 3]
Bryum caespiticium Hedw. [1]
Buxbaumia aphylla Hedw.
Callicladium haldanianum (Grev.) Crum [1, 2, 3, 6, 7, 8]
Calliergon cordifolium (Hedw.) Kindb. [3]
Campylium hispidulum (Brid.) Mitt. [1, 3]
Ceratodon purpureus (Hedw.) Brid. [1]
Climacium americanum Brid. (Dirig 1986b)
Climacium dendroides (Hedw.) Web. & Mohr [6]
Dicranella heteromalla (Hedw.) Schimp. [1, 3, 5, 7]
Dicranum flagellare Hedw. [3, 6]
Dicranum montanum Hedw. [1, 2, 6, 11]
Dicranum viride (Sull. & Lesq. in Sull.) Lindb. [3, 11]
Dicranum scoparium Hedw.
Diphyscium foliosum (Hedw.) Mohr [8]
Ditrichum pallidum (Hedw.) Hampe [1]
Entodon cladorrhizans (Hedw.) C. Müll. [2, 3]
Entodon seductrix (Hedw.) C. Müll. [1, 11]
Ephemerum crassinervium (Schwaegr.) Hampe [10]
Eurhynchium pulchellum (Hedw.) Jenn. [2]
Fissidens taxifolius Hedw. [3]
Fontinalis antipyretica Hedw. [4]
Fontinalis hypnoides var. duriaei (Schimp.) Husn. [4]
Funaria hygrometrica Hedw. [1]
Hedwigia ciliata (Hedw.) P. Beauv. [2]
Helodium blandowii (Web. & Mohr) Warnst.
Helodium paludosum (Sull.) Aust. [8]
Homomallium adnatum (Hedw.) Broth. [1]
Hygroamblystegium tenax (Hedw.) Jenn. var. tenax [3]
Hygroamblystegium tenax var. spinifolium (Schimp.) Jenn. [3]

Hypnum curvifolium Hedw. [3]
Hypnum imponens Hedw. [1]
Hypnum lindbergii Mitt. [3, 6]
Hypnum pallescens (Hedw.) P. Beauv. [1, 2, 7, 8, 11]
Leptodictyum riparium (Hedw.) Warnst. [5, 10]
Leskea gracilescens Hedw. [11]
Leucobryum glaucum (Hedw.) Angstr. in Fries [3, 6]
Orthotrichum sordidum Sull. & Lesq. in Aust. [11]
Philonotis fontana (Hedw.) Brid. (Dirig 1986b)
Plagiomnium ciliare (C. Müll.) T. Kop. [3]
Plagiomnium cuspidatum (Hedw.) T. Kop. [1, 2, 3, 5, 6, 11]
Plagiothecium cavifolium (Brid.) Iwats. [3]
Plagiothecium denticulatum (Hedw.) Schimp. in B.S.G. [3, 5]
Plagiothecium laetum Schimp in B.S.G.
Plagiothecium latebricola B.S.G. [6]
Platygyrium repens (Brid.) Schimp. in B.S.G. [2, 3, 6, 11]
Pleurozium schreberi (Brid.) Mitt. [5]
Pogonatum pensilvanicum (Hedw.) P. Beauv. [1]
Pohlia annotina (Hedw.) Lindb. [8]
Pohlia nutans (Hedw.) Lindb. (Dirig 1986b)
Polytrichum commune Hedw. [1, 2, 3, 5]
Polytrichum juniperinum Hedw. [6]
Polytrichum ohionese Ren. & Card.
Polytrichum piliferum Hedw. [1]
Rhizomnium punctatum (Hedw.) T. Kop. [6]
Rhodobryum ontariense (Kindb.) Par. in Kindb. [3]
Rhytidiadelphus triquetrus (Hedw.) Warnst. [6]
Schistidium apocarpum (Hedw.) Bruch & Schimp. in B.S.G. [1]
Schistidium lancifolium (Kindb.) Blom [1, on cement boulder]
Sphagnum affine Ren. & Card. (Dirig, 1986b)
Sphagnum angustifolium (Russ.) C. Jens. (Dirig 1986b)
Sphagnum capillifolium (Ehrh.) Hedw. [3]
Sphagnum centrale C. Jens. in Arnell & C. Jens. [7]
Sphagnum compactum DC. in Lam. & DC. [7, 10]
Sphagnum cuspidatum Ehrh. ex Hoffm. [5]
Sphagnum fallax (Klinggr.) Klinggr. [5]
Sphagnum fimbriatum Wils. in Wils. & Hook. [3, 5, 6, 8]
Sphagnum flexuosum Dozy & Molk. (Dirig 1986b)
Sphagnum fuscum (Schimp.) Klinggr. (Dirig 1986b)
Sphagnum girgensohnii Russ.
Sphagnum henryense Warnst. (Dirig 1986b)
Sphagnum isoviitae Flatb. [5, 7]
Sphagnum lescurii Sull. in Gray [5]
Sphagnum magellanicum Brid. [5, 6]
Sphagnum palustre L. [3, 8]
Sphagnum platyphyllum (Lindb. ex Braithw.) Warnst. [5]
Sphagnum recurvum P. Beauv. [5]
Sphagnum squarrosum Crome (Dirig 1986b)
Sphagnum subsecundum Nees in Sturm [5]
Sphagnum torreyanum Sull. (Dirig 1986b)
Steerecleus serrulatus (Hedw.) Robins. [1, 2]
Tetraphis pellucida Hedw. [3, 6]
Thuidium delicatulum (Hedw.) Schimp. in B.S.G. [3, 6]
Ulota crispa (Hedw.) Brid. [11]

# Appendix B

## Vascular Plant Species List

Compiled and edited by George R. Robinson with the assistance of Kathleen Moore
State University of New York at Albany

This checklist is derived from five sources: (1) historic surveys of the Pine Bush region by Stanley Smith, Homer House, and other botanists, as recorded in Rittner (1976a); (2) collections and records maintained by the Albany Pine Bush Preserve Commission; (3) wetland surveys by Mattox (1994); (4) New York Natural Heritage Program surveys (Schneider 1991; Hunt 1995); and (5) records and collections from scientists at the University at Albany. The original and primary sources for most records are notes and collections of Stanley Smith, archived at the New York State Museum. An asterisk (*) following an entry in this list indicates that the species is considered a nonindigenous introduction. Nomenclature follows Mitchell and Tucker (1997), as does classification of native/nonnative status. The text of this list is largely derived from a 3,779-entry electronic database of New York State plants compiled by Richard Mitchell, New York State Museum, in 1999. In brackets following each common name is an indication of the probable status of the species (i.e., whether it remains extant in the Pine Bush). Species whose status is [y] have been confirmed on the basis of recent surveys noted above, with assistance from scientists at the New York State Museum and staff of the Albany Pine Bush Commission. Those with [n] status have been deemed extirpated. Those left blank [ ] may or may not persist in the Albany Pine Bush. The superscript C ([C]) after the status brackets means that the species is considered rare, endangered, threatened, or otherwise imperiled in New York State. Readers who encounter unrecorded or unconfirmed species are asked to bring them to the attention of George Robinson at the University at Albany or Christopher Hawver of the Albany Pine Bush Preserve Commission.

Selaginellaceae
- Selaginella apoda (L.) Fern.
  - Creeping spikemoss [y]

Lycopodiaceae
- Huperzia lucidula (Michx.) Trev.
  - Shining fir clubmoss [ ]
- Lycopodiella inundata (L.) Holub
  - Northern bog clubmoss [y]
- Lycopodium clavatum L.
  - Staghorn clubmoss [y]
- Lycopodium complanatum × tristachyum
  - Zeiller's clubmoss [ ]
- Lycopodium obscurum L.
  - Ground pine [y]
- Lycopodium tristachyum Pursh
  - Ground cedar [y]

Equisetaceae
- Equisetum arvense L.
  - Common horsetail [y]
- Equisetum fluviatile L.
  - Water horsetail [y]
- Equisetum hyemale L.
  - Scouring rush [y]
- Equisetum pratense Ehrh.
  - Meadow horsetail [y][C]
- Equisetum scirpoides Michx.
  - Dwarf scouring rush [ ]
- Equisetum sylvaticum L.
  - Woodland horsetail [y]
- Equisetum variegatum Schleich. ex Weber & Mohr.
  - Variegated horsetail [y]

Ophioglossaceae
- Botrychium dissectum Spreng.
  - Cut-leaf grape-fern [y]
- Botrychium matricariifolium (A. Br. ex Döll) A. Br. ex Koch
  - Daisy-leaf grape-fern [y]
- Botrychium multifidum (Gmel.) Rupr.
  - Leathery grape-fern [ ]
- Botrychium simplex E. Hitchc.
  - Dwarf grape fern [ ]
- Botrychium virginianum (L.) Sw.
  - Rattlesnake fern [y]
- Ophioglossum pusillum Raf.
  - Northern adder's-tongue [ ]

Pteridaceae
- Adiantum pedatum L.
  - Maidenhair fern [y]

Dryopteridaceae
- Athyrium filix-femina (L.) Roth ex Mertens
  - var. angustum (Willd.) Lawson
  - Northern lady-fern [y]
- Athyrium filix-femina (L.) Roth ex Mertens
  - var. asplenioides (Michx.) Farw.
  - Southern lady-fern [y]
- Cystopteris bulbifera (L.) Bernh.
  - Bulblet fern [ ]
- Cystopteris fragilis (L.) Bernh.
  - Fragile fern [ ]
- Deparia acrostichoides (Sw.) Kato
  - Silvery spleenwort [ ]
- Dryopteris carthusiana (Vill.) Fuchs
  - Spinulose wood fern [y]
- Dryopteris clintoniana (D. Eaton ex A. Gray) Dowell
  - Clinton's shield fern [ ]
- Dryopteris cristata (L.) A. Gray
  - Crested wood fern [y]
- Dryopteris goldiana (Hooker ex Goldie) A. Gray
  - Giant wood fern [ ]
- Dryopteris intermedia (Muhl. ex Willd.) A. Gray
  - Fancy fern [y][C]
- Dryopteris marginalis (L.) A. Gray
  - Marginal wood fern [y]
- Matteuccia struthiopteris (L.) Todaro
  - Ostrich fern [y]
- Onoclea sensibilis L.
  - Sensitive fern [y]
- Polypodium virginianum L.
  - Rock polypody [ ]
- Polystichum acrostichoides (Michx.) Schott
  - Christmas fern [y]

Dennstaedtiaceae
- Dennstaedtia punctilobula (Michx.) Moore
  - Hay-scented fern [y]
- Pteridium aquilinum (L.) Kuhn ex Decken
  - Bracken [y]

Osmundaceae
- Osmunda cinnamomea L.
  - Cinnamon fern [y]
- Osmunda claytoniana L.
  - Interrupted fern [y]
- Osmunda regalis L.
  - var. spectabilis (Willd.) A. Gray
  - Royal fern [y]

Thelypteridaceae
- Phegopteris connectilis (Michx.) Watt
  - Northern beech fern [ ]
- Phegopteris hexagonoptera (Michx.) Fée
  - Broad beech fern [ ]
- Thelypteris noveboracensis (L.) Nieuwl.
  - New York fern [y]
- Thelypteris palustris Schott
  - var. pubescens (Laws.) Fern.
  - Marsh fern [y]

Blechnaceae
- Woodwardia virginica (L.) Sm.
  - Virginia chain fern [ ]

Taxaceae
- Taxus canadensis Marsh.
  - American yew [ ]

Pinaceae
- Abies balsamea (L.) Mill.
  - Balsam fir [ ]
- Larix laricina (DuRoi) Koch
  - Tamarack, larch [y]
- Picea abies (L.) Karst.*
  - Norway spruce [y]
- Pinus rigida Mill.
  - Pitch pine [y]
- Pinus strobus L.
  - White pine [y]
- Pinus sylvestris L.*
  - Scotch pine [y]
- Tsuga canadensis (L.) Carr.
  - Eastern hemlock [y]

Cupressaceae
Juniperus virginiana L.
Eastern red cedar [y]

Lauraceae
Lindera benzoin (L.) Blume
Spicebush [y]
Sassafras albidum (Nutt.) Nees
Sassafras [y]

Magnoliaceae
Liriodendron tulipifera L.
Tulip tree [ ]

Aristolochiaceae
Asarum canadense L.
Wild ginger [y]

Cabombaceae
Brasenia schreberi Gmel.
Water-shield [ ]
Cabomba caroliniana A. Gray*
Fanwort [y]

Ceratophyllaceae
Ceratophyllum demersum L.
Coontail [y]

Nymphaeaceae
Nuphar advena (Soland. ex Ait.) R. Br. ex Ait. F.
Yellow pondlily [y]
Nymphaea odorata Dryand ex Ait.
White waterlily [y]

Ranunculaceae
Actaea pachypoda Ell.
White baneberry [ ]
Actaea spicata
ssp. rubra L. (Ait.) Hultén
Red baneberry [y]
Anemone canadensis L.
Canada anemone [y]
Anemone cylindrica A. Gray
Thimbleweed [y]
Anemone quinquefolia L.
Wood anemone [y]
Anemone virginiana L.
Thimbleweed [y]
Aquilegia canadensis L.
Wild columbine [y]
Caltha palustris L.
Marsh marigold [y]
Clematis occidentalis (Hornem.) DC.
Purple clematis [ ]
Clematis virginiana L.
Virgin's-bower [y]
Coptis trifolia (L.) Salisb.
Goldthreads [y]
Hepatica nobilis Mill.
var. obtusa (Pursh) Steyerm.
Blunt-lobed hepatica [y]
Ranunculus abortivus L.
var. abortivus
Small-flowered buttercup [y]
Ranunculus acris L.*
Common buttercup [y]
Ranunculus bulbosus L.*
Bulbous crowfoot [ ]
Ranunculus flabellaris Raf. ex Bigel.
Yellow water-buttercup [n]
Ranunculus flammula L.
Creeping spearwort [ ]
Ranunculus hispidus Michx.
var. nitidus (Muhl. ex Ell.) Duncan
Swamp buttercup [y][C]
Ranunculus pensylvanicus L. f.
Bristly buttercup [y]
Ranunculus recurvatus Poir. ex Lam.
Hooked buttercup [y]
Ranunculus repens L.*
Creeping buttercup [y]
Ranunculus sceleratus L.*
Cursed crowfoot [y]
Thalictrum dioicum L.
Early meadow-rue [y]
Thalictrum pubescens Pursh
Tall meadow-rue [y]
Thalictrum revolutum DC.
Waxy meadow-rue [ ]
Thalictrum thalictroides (L.) Eames & Boivin
Rue anemone [y]

Berberidaceae
Berberis thunbergii DC.*
Japanese barberry [y]
Berberis vulgaris L.*
European barberry [y]
Caulophyllum thalictroides (L.) Michx.
Blue cohosh [y]
Podophyllum peltatum L.
May-apple [y]

Fumariaceae
Dicentra cucullaria (L.) Bernh.
Dutchman's-breeches [y]

Papaveraceae
- Chelidonium majus L.*
  - Greater celandine [y]
- Eschscholzia californica Cham. ex Nees*
  - California poppy [ ]
- Papaver dubium L.*
  - Cornfield poppy [ ]
- Papaver rhoeas L.*
  - Corn poppy [ ]
- Sanguinaria canadensis L.
  - Bloodroot [y]

Hamamelidaceae
- Hamamelis virginiana L.
  - Witch-hazel [y]

Urticaceae
- Boehmeria cylindrica (L.) Sw.
  - False-nettle [y]
- Laportea canadensis (L.) Wedd.
  - Wood-nettle [ ]
- Parietaria pensylvanica Muhl. ex Willd.
  - Pellitory [ ]
- Pilea pumila (L.) A. Gray
  - Richweed [y]
- Urtica dioica L.
  - ssp. gracilis (Ait.) Selander
  - Stinging nettle [y]

Moraceae
- Morus alba L.*
  - White mulberry [y]

Cannabaceae
- Humulus japonicus Sieb. & Zucc.*
  - Japanese hops [ ]
- Humulus lupulus L.*
  - Common hop [ ]

Ulmaceae
- Ulmus americana L.
  - American elm [y]
- Ulmus pumila L.*
  - Dwarf elm [y]
- Ulmus rubra Muhl.
  - Slippery elm [y]

Juglandaceae
- Carya cordiformis (Wang.) Koch
  - Bitternut [y]
- Carya glabra (Mill.) Sweet
  - Pignut [y]
- Carya ovata (Mill.) Koch
  - Shagbark hickory [y]
- Carya tomentosa (Poir. ex Lam.) Nutt.
  - Mockernut [y]
- Juglans cinerea L.
  - Butternut [y]

Myricaceae
- Comptonia peregrina (L.) Coult.
  - Sweet-fern [y]
- Myrica pensylvanica Loisel. ex Duhamel
  - Bayberry [ ]

Betulaceae
- Alnus incana (L.) Moench
  - ssp. rugosa × serrulata
  - Speckled alder [y]
- Alnus serrulata (Dryand. ex Ait.) Willd.
  - Smooth alder [y]
- Betula alleghaniensis Britt.
  - Yellow birch [y]
- Betula lenta L.
  - Sweet birch [y]
- Betula papyrifera Marsh.
  - Paper birch [y]
- Betula populifolia Marsh.
  - Gray birch [y]
- Carpinus caroliniana Walt.
  - ssp. virginiana (Marsh.) Furlow
  - Hop hornbeam [y]
- Corylus americana Walt.
  - Hazelnut [y]
- Corylus cornuta Marsh.
  - Beaked hazel [y]
- Ostrya virginiana (Mill.) Koch
  - Hop hornbeam [y]

Fagaceae
- Castanea dentata (Marsh.) Borkh.
  - American chestnut [y]
- Fagus grandifolia Ehrh.
  - American beech [y]
- Quercus alba L.
  - White oak [y]
- Quercus alba × bicolor
  - Hybrid oak [ ]
- Quercus bicolor Willd.
  - Swamp white oak [y]
- Quercus coccinea Muenchh.
  - Scarlet oak [y]
- Quercus ilicifolia Wang.
  - Scrub oak [y]
- Quercus montana Willd.
  - Chestnut oak [y]
- Quercus prinoides Willd.
  - Dwarf chestnut oak [y]

Quercus rubra L.
Red oak [y]
Quercus velutina Lam.
Black oak [y]

Caryophyllaceae
Agrostemma githago L.*
Corn-cockle [ ]
Arenaria serpyllifolia L.*
Thyme-leaf sandwort [ ]
Cerastium fontanum Baumg. emend
Jalas*
Common mouse-ear [y]
Dianthus armeria L.*
Deptford pink [y]
Lychnis coronaria (L.) Desr.*
Rose-campion [ ]
Lychnis viscaria L.*
German catch-fly [ ]
Minuartia michauxii (Fenzl) Farw.
Rock sand-wort [ ]
Moehringia lateriflora (L.) Fenzl
Grove sandwort [y]
Myosoton aquaticum (L.) Moench*
Giant chickweed [ ]
Sagina procumbens L.*
Pearlwort [ ]
Saponaria officinalis L.*
Bouncing-bet [y]
Scleranthus annuus L.*
Knawel [y]
Silene antirrhina L.
Sleepy catch-fly [y]
Silene armeria L.*
Sweet-william [y]
Silene dichotoma Ehrh.*
Forked catch-fly [ ]
Silene latifolia Poir.*
White campion [y]
Silene vulgaris (Moench) Garcke*
Bladder-campion [y]
Stellaria borealis Bigel.
Northern starwort [ ]
Stellaria graminea L.*
Common stitchwort, lesser
stitchwort [y]
Stellaria longifolia Muhl. ex Willd.
Needle-leaf starwort [ ]
Stellaria media (L.) Vill.*
Common chickweed [y]

Amaranthaceae
Amaranthus albus L.*
Tumbleweed [y]
Amaranthus blitoides S. Wats.*
Prostrate amaranth [y]
Amaranthus hybridus L.*
Green amaranth [ ]
Amaranthus powellii S. Wats.*
Amaranth [ ]
Amaranthus retroflexus L.
Pigweed [y]

Chenopodiaceae
Atriplex patula L.
Seaside orach [ ]
Bassia scoparia (L.) A. Scott*
Summer cypress [ ]
Chenopodium album L.*
Lamb's-quarters [y]
Chenopodium ambrosioides L.*
Mexican tea [ ]
Chenopodium botrys L.*
Jerusalem-oak [ ]
Chenopodium pratericola Rydb.*
Narrow-leaf goosefoot [ ]
Chenopodium simplex (Torrey) Raf.
Maple-leaf goosefoot [ ]
Cycloloma atriplicifolium (Spreng.)
Coult.*
Winged pigweed [y]
Salsola kali L.*
Russian thistle [y]

Portulacaceae
Claytonia caroliniana Michx.
Broad-leaved spring beauty [ ]
Portulaca oleracea L.*
Purslane [y]

Nyctaginaceae
Mirabilis hirsuta (Pursh) MacM.*
Hairy umbrella-wort [ ]
Mirabilis nyctaginea (Michx.) MacM.*
Heartleaf umbrella-wort [y]

Molluginaceae
Mollugo verticillata L.*
Carpetweed [ ]

Phytolaccaceae
Phytolacca americana L.
Poke [y]

Polygonaceae
Fagopyrum esculentum Moench.*
Buckwheat [ ]
Polygonella articulata (L.) Meisn.
Jointweed [y]

Polygonum achoreum Blake
Homeless knotweed [ ]
Polygonum amphibium L.
var. laevimarginatum L.
Water lady's thumb [ ]
Polygonum arifolium L.
Arrowleaf tearthumb [y]
Polygonum aviculare L.*
Knotweed [y]
Polygonum careyi Olney
Smartweed [y]C
Polygonum cespitosum Blume
var. longisetum (DeBruyn) Stewart*
Japanese lady's-thumb [y]
Polygonum convolvulus L.*
Black bindweed [y]
Polygonum cuspidatum Sieb. & Zucc.*
Japanese bamboo [y]
Polygonum erectum L.
Erect knotweed [ ]C
Polygonum hydropiper L.*
Common smartweed [y]
Polygonum hydropiperoides Michx.
Mild water-pepper [y]
Polygonum lapathifolium L.*
Willow-weed [y]
Polygonum pensylvanicum L.
Pinkweed [y]
Polygonum persicaria L.*
Lady's-thumb [y]
Polygonum punctatum Ell.
var. confertiflorum (Meisn.) Fassett
Dotted smartweed [y]
Polygonum punctatum Ell.
var. punctatum
Dotted smartweed [y]
Polygonum ramosissimum Michx.
var. ramosissimum*
Knotweed [y]
Polygonum sagittatum L.
Tearthumb [y]
Polygonum scandens L.
Climbing false-buckwheat [y]
Polygonum scandens L.
var. dumetorum (L.) Gleason*
Climbing false-buckwheat [ ]
Polygonum virginianum L.
Jumpseed [y]
Rheum rhabarbarum L.
Rhubarb [ ]
Rumex acetosella L.*
Sheep sorrel [y]
Rumex altissimus Wood
Pale dock [y]
Rumex crispus L.*
Curly dock [y]
Rumex obtusifolius L.*
Bitter-dock, red-veined dock [ ]
Rumex orbiculatus A. Gray
Great water dock [y]
Rumex patientia L.*
Patience dock [y]
Rumex verticillatus L.
Swamp dock [ ]

Clusiaceae
Hypericum boreale (Britt.) Bickn.
Northern dwarf St. John's wort [ ]
Hypericum canadense L.
Canadian St. John's-wort [ ]
Hypericum ellipticum Hooker
Pale St. John's-wort [ ]
Hypericum gentianoides (L.) BSP.
Orange-grass [ ]
Hypericum kalmianum L.
Kalm St. John's-wort [ ]C
Hypericum majus (A. Gray) Britt.
Canadian St. John's-wort [ ]
Hypericum mutilum L.
Dwarf St. John's-wort [y]
Hypericum perforatum L.*
Common St. John's-wort [y]
Hypericum punctatum Lam.
St. John's-wort [y]
Triadenum fraseri (Spach) Gleason
Marsh St. John's-wort [y]
Triadenum virginicum (L.) Raf.
Marsh St. John's-wort [y]

Malvaceae
Abutilon theophrasti Medik.*
Velvet-leaf [y]
Malva neglecta Wallr.*
Cheeses [y]

Tiliaceae
Tilia americana L.
var. americana
Basswood [y]
Tilia americana L.
var. heterophylla (Vent.) Loud.
White basswood [ ]

Droseraceae
Drosera intermedia Hayne
Sundew [n]
Drosera rotundifolia L.
Round-leaf sundew [y]

Sarraceniaceae
Sarracenia purpurea L.
Pitcher-plant [n]

Cucurbitaceae
Cucumis sativus L.*
Garden cucumber [ ]
Echinocystis lobata (Michx.) Torrey & A. Gray
Wild cucumber [y]
Sicyos angulatus L.
Bur cucumber [y]

Cistaceae
Helianthemum bicknellii Fern.
Pine-barren frostweed [ ]
Helianthemum canadense (L.) Michx.
Frostweed [y]
Lechea intermedia Leggett ex Britt.
Pinweed [ ]
Lechea mucronata Raf. ex Desv.
Pinweed [ ]

Violaceae
Viola affinis LeConte
Leconte violet [ ]
Viola blanda Willd.
Sweet white violet [y]
Viola canadensis L.
Tall white violet [ ]
Viola conspersa Reichenb.
American dog-violet [y]
Viola cucullata Ait.
Blue marsh violet [y]
Viola lanceolata L.
Lance-leaf violet [y]
Viola macloskeyi Lloyd
ssp. pallens (Banks ex DC.) M. Baker
Pale violet [y]
Viola palmata L.
Early blue violet [ ]
Viola pedata L.
Bird's-foot violet [y]
Viola pubescens Ait.
Downy yellow violet [ ]
Viola rostrata Pursh
Long-spurred violet [y]
Viola rotundifolia Michx.
Round-leaf violet [ ]
Viola sagittata Ait.
Arrow-leaf violet [y]
Viola sagittata × sororia
Violet [ ]
Viola selkirkii Pursh ex Goldie
Great spurred violet [ ]
Viola septentrionalis Greene
Northern blue violet [ ]
Viola sororia Willd.
Woolly blue violet [ ]
Viola tricolor L.*
Johnny jump-up [ ]

Salicaceae
Populus alba L.*
White poplar [y]
Populus balsamifera L.
Balsam poplar [y]
Populus deltoides Bartr. ex Marsh.
Cottonwood [y]
Populus grandidentata Michx.
Big-toothed aspen [y]
Populus nigra L.*
Lombardy poplar [ ]
Populus tremuloides Michx.
Quaking aspen [y]
Salix alba L.*
White willow [y]
Salix bebbiana Sarg.
Beaked willow [y]
Salix discolor Muhl.
Pussy-willow [y]
Salix eriocephala Michx.
Stiff willow [ ]
Salix exigua Nutt.
Sandbar willow [y]
Salix fragilis L.*
Crack-willow [ ]
Salix humilis Marsh.
var. humilis
Prairie willow [y]
Salix humilis Marsh.
var. tristis (Ait.) Griggs
Dwarf upland willow, dune willow [y]
Salix lucida Muhl.
Shining willow [y]
Salix nigra Marsh.
Black willow [y]
Salix pedicellaris Pursh
Bog willow [y]
Salix pentandra L.*
Bay-leaf willow [ ]
Salix petiolaris Sm.
Slender willow [y]
Salix petiolaris × sericea
Willow [ ]
Salix purpurea L.*
Purple willow [ ]

Salix sericea Marsh.
Silky willow [y]

Brassicaceae
Alliaria petiolata (Bieb.) Cav. & Grande*
Garlic mustard [y]
Alyssum alyssoides (L.) L.*
Alyssum [y]
Arabis glabra (L.) Bernh.
Tower-mustard [y]
Arabis laevigata (Muhl. ex Willd.) Poir. ex Lam
Smooth rock-cress [y]
Arabis lyrata (L.)
Lyre-leaf rock-cress [ ]
Barbarea vulgaris R. Br. ex Ait.*
Cress [y]
Berteroa incana (L.) DC.*
Hoary alyssum [y]
Brassica nigra (L.) Koch*
Black mustard [y]
Capsella bursa-pastoris (L.) Medik.*
Shepherd's-purse [y]
Cardamine bulbosa (Schreb. ex Muhl.) BSP.
Spring cress [y]
Cardamine diphylla (Michx.) Wood
Two-leaf toothwort [y]
Cardamine pensylvanica Muhl. ex Willd.
Pennsylvania bittercress [y]
Coronopus didymus (L.) Sm.*
Wart-cress [ ]
Draba verna L.*
Whitlow-grass [ ]
Erucastrum gallicum (Willd.) Schulz*
French rocket [ ]
Lepidium campestre (L.) R. Br. ex Ait.*
Cow-cress [y]
Lepidium densiflorum Schrad.*
Bird's peppergrass [y]
Lepidium virginicum L.
Wild peppergrass [y]
Lobularia maritima (L.) Desv.*
Sweet alyssum [ ]
Raphanus raphanistrum L.*
Wild radish [y]
Rorippa nasturtium-aquaticum (L.) Hayek*
Watercress [y]
Rorippa palustris (L.) Besser ssp. fernaldiana (Butters & Abbe) Jonsell*
Marsh watercress [n]
Rorippa sylvestris (L.) Besser*
Creeping yellow-cress [ ]
Sinapis arvensis L.*
Charlock [y]
Sisymbrium altissimum L.*
Tumble-mustard [y]
Sisymbrium officinale (L.) Scop.*
Hedge-mustard [ ]

Capparidaceae
Polanisia dodecandra (L.) DC.*
Clammyweed [y]

Ericaceae
Andromeda glaucophylla Link
Marsh rosemary [ ]
Chamaedaphne calyculata (L.) Moench
Leatherleaf [y]
Chimaphila maculata (L.) Pursh
Spotted wintergreen [y]
Chimaphila umbellata (L.) Bart. ssp. cisatlantica (Blake) Hultén
Pipsissewa [y]
Epigaea repens L.
Trailing arbutus [y]
Gaultheria procumbens L.
Wintergreen [y]
Gaylussacia baccata (Wang.) Koch
Black huckleberry [y]
Kalmia angustifolia L.
Sheep laurel [y]
Kalmia polifolia Wang.
Bog laurel [n]
Lyonia ligustrina (L.) DC.
Maleberry [y]
Moneses uniflora (L.) A. Gray
One-flowered wintergreen [ ]
Monotropa uniflora L.
Indian-pipe [y]
Orthilia secunda (L.) House
One-sided wintergreen [ ]
Pterospora andromedea Nutt.
Pine-drops [ ][C]
Pyrola americana Sweet
Wild lily-of-the-valley [y]
Pyrola asarifolia Michx.
Pink wintergreen [ ]
Pyrola chlorantha Sw.
Green shinleaf [ ]
Pyrola elliptica Nutt.
Shinleaf [y]
Rhododendron groenlandicum (Oeder) Kron & Judd
Labrador tea [n]

Rhododendron periclymenoides (Michx.) Shinners
Pinkster-flower [y]
Rhododendron prinophyllum (Small) Millais
Early azalea [y]
Rhododendron viscosum (L.) Torrey
Swamp azalea [y]
Vaccinium angustifolium Ait.
Lowbush blueberry [y]
Vaccinium corymbosum L.
Highbush blueberry [y]
Vaccinium macrocarpon Ait.
American cranberry [ ]
Vaccinium pallidum Ait.
Hillside blueberry, low blueberry [y]
Vaccinium stamineum L.
Deerberry [y]

Primulaceae
Lysimachia ciliata L.
Fringed loosestrife [y]
Lysimachia nummularia L.
Moneywort [y]
Lysimachia quadriflora Sims
Four-flowered loosestrife [y][C]
Lysimachia quadrifolia L.
Whorled loosestrife [y]
Lysimachia quadrifolia × terrestris
Hybrid loosestrife [ ]
Lysimachia terrestris (L.) BSP.
Swamp-candles [y]
Lysimachia thyrsiflora L.
Tufted loosestrife [y]
Lysimachia vulgaris L.*
Garden loosestrife [ ]
Trientalis borealis Raf.
Starflower [y]

Rosaceae
Agrimonia gryposepala Wallr.
Common agrimony [y]
Agrimonia parviflora Soland ex Ait.
Agrimony [ ]
Agrimonia pubescens Wallr.
Agrimony [ ]
Agrimonia rostellata Wallr.
Agrimony [n][C]
Agrimonia striata Michx.
Agrimony [ ]
Amelanchier arborea (Michx. f.) Fern.
Shadbush [y]
Amelanchier arborea × canadensis
Serviceberry [ ]
Amelanchier canadensis (L.) Medik.
Serviceberry [y]
Amelanchier humilis Wieg.
Bush juneberry [y]
Amelanchier laevis Wieg.
Smooth shadbush [y]
Amelanchier sanguinea (Pursh) DC.
Roundleaf juneberry [y]
Amelanchier stolonifera Wieg.
Bush juneberry [y]
Aronia arbutifolia (L.) Pers.
Red chokeberry [y]
Aronia melanocarpa (Michx.) Ell.
Black chokeberry [y]
Aronia × prunifolia (Marsh.) Rehd.
Purple chokeberry [y]
Chaenomeles japonica (Thunb.) Lindl. ex Spach*
Lesser flowering quince [ ]
Crataegus brainerdii Sarg.
Hawthorn [ ]
Crataegus chrysocarpa Ashe
Round-leaf hawthorn [ ]
Crataegus coccinioides Ashe
Hawthorn [ ]
Crataegus crusgalli L.
Cockspur [y]
Crataegus holmesiana Ashe
Hawthorn [ ]
Crataegus intricata Lange
Hawthorn [ ]
Crataegus macrosperma Ashe
Big-fruited haw [y]
Crataegus monogyna Jacq.*
English hawthorn [ ]
Crataegus opulens Sarg.
Hawthorn [n]
Crataegus pedicellata Sarg.
Scarlet thorn [ ]
Crataegus pringlei Sarg.
Hawthorn [ ]
Crataegus pruinosa (Wendl. f.) Koch
Hawthorn [ ]
Crataegus punctata Jacq.
Dotted haw [ ]
Crataegus succulenta Schrad. ex Link
Hawthorn [ ]
Fragaria chiloensis (L.) Mill.*
Coast strawberry [y]
Fragaria chiloensis × virginiana*
Strawberry [ ]
Fragaria virginiana Dene.
Field strawberry [y]
Geum aleppicum Jacq.
Yellow avens [y]

Geum canadense Jacq.
White avens [y]
Geum laciniatum Murr.
Rough avens [y]
Geum rivale L.
Purple avens [y]
Malus pumila Mill.*
Common apple [y]
Physocarpus opulifolius (L.) Maxim.
Ninebark [ ]
Potentilla anserina L.
Silverweed [ ]
Potentilla argentea L.*
Silvery cinquefoil [ ]
Potentilla canadensis L.
Dwarf cinquefoil [y]
Potentilla intermedia L.*
Cinquefoil [y]
Potentilla norvegica L.
ssp. monspeliensis (L.) Aschers. & Gräbn.
Rough cinquefoil [y]
Potentilla palustris (L.) Scop.
Marsh cinquefoil [ ]
Potentilla recta L.*
Sulfur cinquefoil [y]
Potentilla simplex Michx.
Common cinquefoil [y]
Prunus americana Marsh.
Hedge-plum [y]
Prunus pensylvanica L. f.
Fire-cherry, pin-cherry [y]
Prunus persica (L.) Batsch*
Peach [ ]
Prunus pumila L.
var. susquehanae (Hort. ex Willd.) Jaeger
Sand-cherry, eastern dwarf cherry [y]
Prunus serotina Ehrh.
Black cherry [y]
Prunus virginiana L.
Chokecherry [y]
Pyrus communis L.*
Pear [ ]
Rosa canina L.*
Dog rose [ ]
Rosa carolina L.
Pasture rose [y]
Rosa eglanteria L.*
Sweetbrier [ ]
Rosa palustris Marsh.
Swamp rose [y]
Rosa rugosa Thunb.*
Japanese rose [ ]
Rosa setigera Michx.
Prairie rose [ ]
Rosa virginiana Mill.
Wild rose [ ]
Rubus allegheniensis Porter ex Bailey
Northern blackberry [y]
Rubus argutus Link
Tall blackberry [y]
Rubus arundelanus Blanch.
Sand blackberry [ ]
Rubus canadensis L.
Thornless blackberry [ ]
Rubus flagellaris Willd.
American dewberry [y]
Rubus hispidus L.
Swamp dewberry [y]
Rubus idaeus L.
Red raspberry [y]
Rubus idaeus L.
ssp. strigosus (Michx.) Focke
Wild raspberry [y]
Rubus occidentalis L.
Black raspberry [y]
Rubus odoratus L.
Pink thimbleberry [y]
Rubus pensilvanicus Poir. ex Lam.
Highbush blackberry [ ]
Rubus pubescens Raf.
Dwarf raspberry [y]
Rubus setosus Bigel.
Bog blackberry [ ]
Sorbaria sorbifolia (L.) A. Br.*
False spiraea [ ]
Sorbus aucuparia L.*
European mountain ash [y]
Spiraea alba DuRoi
var. alba
Meadow-sweet [y]
Spiraea alba DuRoi
var. latifolia (Ait.) Dippel
Meadow-sweet [y]
Spiraea douglasii × salicifolia*
Spiraea [ ]
Spiraea tomentosa L.
Hardhack, steeplebush [y]
Waldsteinia fragarioides (Michx.) Tratt.
Barren strawberry [ ]

Saxifragaceae
Chrysosplenium americanum Schwein. ex Hooker
Golden saxifrage [y]
Mitella diphylla L.
Coolwort [y]

Parnassia glauca Raf.
Grass-of-Parnassus [n]
Saxifraga pensylvanica L.
Swamp saxifrage [n]
Tiarella cordifolia L.
Foamflower [y]

Crassulaceae
Penthorum sedoides L.
Ditch-stonecrop [y]
Sedum sarmentosum Bunge*
Orpine [ ]
Sedum spurium Bieb.*
Rosy stonecrop [ ]
Sedum telephium L.*
Live-forever [ ]

Grossulariaceae
Ribes americanum Mill.
Wild black currant [y]
Ribes cynosbati L.
Dogberry [y]
Ribes hirtellum Michx.
Northern gooseberry [ ]
Ribes rubrum L.*
Northern red currant [ ]
Ribes triste Pallas
Swamp red currant [y]

Fabaceae
Amorpha fruticosa L.*
False indigo [ ]
Amphicarpaea bracteata (L.) Rickett & Stafleu
Hog-peanut [y]
Apios americana Medik.
Groundnut [y]
Baptisia tinctoria (L.) Vent.
Wild indigo [ ]
Coronilla varia L.*
Crown-vetch [y]
Desmodium canadense (L.) DC.
Giant tick-clover [y]
Desmodium canescens (L.) DC.
Hoary tick-clover [y]
Desmodium ciliare (Muhl. ex Willd.) DC.
Tick-clover [n][C]
Desmodium glutinosum (Muhl. ex Willd.) Wood
Sticky tick-clover [y]
Desmodium nudiflorum (L.) DC.
Tick-trefoil [y]
Desmodium rotundifolium DC.
Tick-clover [ ]
Genista tinctoria L.*
Dyer's greenweed [ ]
Gleditsia triacanthos L.*
Honey-locust [y]
Lathyrus latifolius L.*
Everlasting pea [ ]
Lespedeza capitata Michx.
Bush-clover [y]
Lespedeza hirta (L.) Hornem.
Lespedeza [y]
Lespedeza procumbens Michx.
Trailing lespedeza [ ]
Lespedeza thunbergii (DC.) Nakai*
Lespedeza [ ]
Lotus corniculata L.*
Bird's-foot trefoil [y]
Lupinus perennis L.
Wild lupine [y]
Medicago lupulina L.*
Black medick [y]
Medicago sativa L.*
Alfalfa [ ]
Melilotus alba Desr. ex Lam.*
White sweet-clover [y]
Melilotus officinalis (L.) Pallas*
Yellow melilotus [y]
Robinia hispida L.*
Rose-acacia [y]
Robinia pseudo-acacia L.*
Black locust [y]
Robinia viscosa Vent. ex Vauq.*
Clammy locust [ ]
Senna hebecarpa (Fern.) Irwin & Barneby
Wild senna [ ]
Strophostyles helvula (L.) Ell.
Annual woolly-bean [ ]
Tephrosia virginiana (L.) Pers.
Goat's-rue [y]
Trifolium arvense L.*
Rabbit's-foot clover [y]
Trifolium aureum Pollich*
Yellow clover [ ]
Trifolium campestre Schreb.*
Hop-clover [ ]
Trifolium dubium Sibth.*
Hop-clover [ ]
Trifolium hybridum L.*
Alsike clover [ ]
Trifolium incarnatum L.*
Scarlet clover [y]
Trifolium pratense L.*
Red clover [y]
Trifolium repens L.*
White clover [y]

Vicia cracca L.
Cow-vetch [y]
Vicia sativa L.*
Common vetch [y]
Vicia tetrasperma (L.) Schreb.*
Lentil-vetch [y]
Vicia villosa
ssp. villosa Roth*
Hairy vetch [ ]
Wisteria sinensis (Sims) Sweet*
Chinese wisteria [y]

Haloragaceae
Proserpinaca palustris L.
var. crebra Fern. & Grisc.
Mermaid-weed [ ]

Onagraceae
Circaea alpina L.
Dwarf enchanter's nightshade [y]
Circaea lutetiana L.
ssp. canadensis (L.) Aschers. & Magnus
Enchanter's nightshade [y]
Epilobium angustifolium L.
Willow-herb [y]
Epilobium ciliatum Raf.
Willow-herb [y]
Epilobium coloratum Biehl.
Purple-leaf willow-herb [y]
Epilobium hirsutum L.*
European fireweed [ ]
Epilobium leptophyllum Raf.
Willow-herb [y]
Epilobium strictum Muhl. ex Spreng.
Downy willow-weed [ ]
Gaura biennis L.*
Gaura [ ]
Ludwigia alternifolia L.
Seedbox [y]
Ludwigia palustris (L.) Ell.
Water purslane [y]
Oenothera biennis L.
Common evening-primrose [y]
Oenothera clelandii Dietrich, Raven & Wagner*
Evening-primrose [ ]
Oenothera parviflora L.
Evening-primrose [ ]
Oenothera perennis L.
Sundrops [ ]

Lythraceae
Lythrum alatum Pursh
Winged loosestrife [n]
Lythrum salicaria L.*
Purple loosestrife [y]
Rotala ramosior (L.) Koehne ex Mart.
Tooth-cup [n]C

Thymeliaceae
Daphne mezereum L.*
Daphne [ ]
Dirca palustris L.
Leatherwood [y]

Trapaceae
Trapa natans L.*
Water-chestnut [y]

Cornaceae
Cornus alternifolia L. f.
Green osier [y]
Cornus amomum
ssp. amomum Mill.
Silky dogwood [y]
Cornus canadensis L.
Bunchberry [y]
Cornus florida L.
Flowering dogwood [y]
Cornus foemina Mill.
ssp. racemosa (Lam.) J. Wilson
Gray dogwood [y]
Cornus rugosa Lam.
Round-leaf dogwood [y]
Cornus sericea L.
Red osier [y]

Nyssaceae
Nyssa sylvatica Marsh.
Black gum [y]

Santalaceae
Comandra umbellata (L.) Nutt.
Bastard-toadflax [y]

Celastraceae
Celastrus orbiculata Thunb.*
Oriental bittersweet [y]
Celastrus scandens L.
American bittersweet [y]
Euonymus americana L.
Strawberry-bush [y]C
Euonymus europaea L.*
European spindle-tree [y]

Aquifoliaceae
Ilex laevigata (Pursh) A. Gray
Smooth winterberry [ ]

Ilex verticillata (L.) A. Gray
Winterberry [y]
Nemopanthus mucronatus (L.) Loesener ex Koehne
Mountain holly [y]

Euphorbiaceae
Acalypha virginica L.
var. rhomboidea (Raf.) Cooperrider
Three-seeded mercury [y]
Chamaesyce glyptosperma (Engelm.) Small
Spurge [y]
Chamaesyce maculata (L.) Small
Eyebane [y]
Chamaesyce nutans (Lag.) Small
Eyebane [ ]
Euphorbia corollata L.
Flowering spurge [y]
Euphorbia cyparissias L.*
Cypress spurge [y]
Euphorbia esula L.*
Wolf's-milk [ ]
Euphorbia marginata Pursh*
Snow-on-the-mountain [y]

Vitaceae
Parthenocissus quinquefolia (L.) Planch. ex DC.
Virginia creeper [y]
Parthenocissus vitacea (L.) Planch. ex DC.
Virginia creeper [y]
Vitis aestivalis Michx.
Summer grape [y]
Vitis riparia Michx.
Frost grape [y]
Vitis vulpina L.
Winter grape [ ]C

Linaceae
Linum sulcatum Ridd.
Yellow wild flax [ ]C

Rhamnaceae
Ceanothus americanus L.
New Jersey tea [y]
Rhamnus alnifolia L'Hér.
Alder-leaf buckthorn [n]
Rhamnus cathartica L.*
Common buckthorn [y]
Rhamnus frangula L.*
Smooth buckthorn [y]

Polygalaceae
Polygala paucifolia Willd.
Fringed milkwort [y]
Polygala polygama Walt.
Bitter milkwort [ ]
Polygala sanguinea L.
Rose milkwort [y]
Polygala senega L.
Seneca snakeroot [ ]
Polygala verticillata L.
Whorled milkwort [ ]
Polygala verticillata L.
var. isocycla Fern.
Whorled milkwort [ ]

Aceraceae
Acer campestre L.*
Hedge-maple [ ]
Acer negundo L.
Box-elder [y]
Acer nigrum Michx. f.
Black maple [ ]
Acer pensylvanicum L.
Striped maple [y]
Acer rubrum L.
var. rubrum
Red maple [y]
Acer saccharum Marsh.
Sugar maple [ ]

Hippocastanaeeae
Aesculus hippocastanum L.*
Horse-chestnut [ ]

Simaroubaceae
Ailanthus altissima (Mill.) Swingle*
Tree-of-heaven [y]

Anacardiaceae
Cotinus coggygria Scop.*
Smoke-tree [ ]
Rhus copallinum L.
Winged sumac [y]
Rhus glabra L.
Smooth sumac [y]
Rhus hirta (L.) Sudworth
Staghorn sumac [y]
Toxicodendron radicans (L.) Kuntze
Poison ivy [y]
Toxicodendron vernix (L.) Kuntze
Poison sumac [y]

Rutaceae
Dictamnus albus L.*
Gas-plant [ ]

Zanthoxylum americanum Mill.
Prickly ash [y]

Staphyleaceae
Staphylea trifolia L.
Bladdernut [y]

Geraniaceae
Geranium bicknellii Britt.
Geranium [ ]
Geranium maculatum L.
Wild geranium [y]

Balsaminaceae
Impatiens capensis Meerb.
Spotted touch-me-not [y]
Impatiens pallida Nutt.
Pale jewelweed [y]

Oxalidaceae
Oxalis corniculata L.*
Lady's-sorrel [y]
Oxalis stricta L.
Lady's-sorrel [y]

Apiaceae
Angelica atropurpurea L.
Alexanders [y]
Cicuta bulbifera L.
Water-hemlock [y]
Cicuta maculata L.
Poison hemlock [y]
Cryptotaenia canadensis (L.) DC.
Honewort [y]
Daucus carota L.*
Queen-Anne's-lace [y]
Hydrocotyle americana L.
Pennywort [y]
Osmorhiza claytonii (Michx.) Clarke
Sweet jarvil [ ]
Pastinaca sativa L.*
Wild parsnip [y]
Pimpinella major (L.) Huds.*
Pimpinella [ ]
Sanicula marilandica L.
Black snakeroot [y]
Sanicula odorata (Raf.) Pryer & Phillippe
Sanicle [ ]
Sanicula trifoliata Bickn.
Sanicle [ ]
Sium suave Walt.
Water-parsnip [y]
Zizia aptera (A. Gray) Fern.
Golden Alexanders [ ]
Zizia aurea (L.) Koch
Golden Alexanders [y]

Araliaceae
Aralia nudicaulis L.
Wild sarsaparilla [y]
Aralia racemosa L.
Spikenard [ ]
Panax quinquefolius L.
Ginseng [ ]
Panax trifolius L.
Dwarf ginseng [ ]

Apocynaceae
Apocynum androsaemifolium L.
Spreading dogbane [y]
Apocynum androsaemifolium Œ cannabinum
Dogbane [ ]
Apocynum cannabinum L.
var. cannabinum
Indian hemp [y]
Apocynum cannabinum L.
var. hypericifolium A. Gray
Indian hemp [ ]

Asclepiadaceae
Asclepias amplexicaulis Sm.
Blunt-leaf milkweed [y]
Asclepias exaltata L.
Poke milkweed [y]
Asclepias incarnata L.
var. pulchra (Ehrh. ex Willd.) Pers.
Swamp milkweed [y]
Asclepias quadrifolia Jacq.
Four-leaf milkweed [ ]
Asclepias syriaca L.
Common milkweed [y]
Asclepias tuberosa L.
var. interior (Woodson) Shinners
Butterfly-weed [y]

Gentianaceae
Bartonia virginica (L.) BSP.
Bartonia [y]
Gentiana clausa Raf.
Blind gentian [ ]
Gentiana saponaria L.
Soapwort gentian [ ]C
Gentianella quinquefolia (L.) Small
Stiff gentian [ ]
Gentianopsis crinita (Froel.) Ma
Fringed gentian [y]

Solanaceae
- Datura stramonium L.
  - Jimson weed [y]
- Petunia axillaris (Lam.) BSP.*
  - Garden petunia [ ]
- Physalis heterophylla Nees
  - Clammy ground-cherry [y]
- Physalis longifolia Nutt.
  - Long-leaf ground-cherry [ ]
- Physalis virginiana Mill.
  - Virginia ground-cherry [ ][C]
- Solanum carolinense L.
  - Horse-nettle [y]
- Solanum dulcamara L.*
  - Trailing nightshade [y]
- Solanum ptycanthum Dunal.*
  - Black nightshade [y]

Convolvulaceae
- Calystegia sepium (L.) R Br.
  - Hedge-bindweed [y]
- Calystegia spithamea (L.) Pursh
  - Low bindweed [y]
- Convolvulus arvensis L.*
  - Field bindweed [ ]
- Ipomoea purpurea (L.) Roth*
  - Common morning-glory [y]

Polemoniaceae
- Phlox divaricata L.
  - Blue phlox [y]
- Phlox paniculata L.
  - Fall phlox [y]

Cuscutaceae
- Cuscuta gronovii Willd. ex Schultz
  - Dodder [y]

Hydrophyllaceae
- Hydrophyllum virginianum L.
  - Virginia waterleaf [ ]

Menyanthaceae
- Menyanthes trifoliata L.
  - var. minor Raf.
  - Buckbean [ ]

Lamiaceae
- Ajuga reptans L.*
  - Carpet-bugleweed [ ]
- Clinopodium vulgare L.*
  - Basil [ ]
- Collinsonia canadensis L.
  - Richweed [y]
- Galeopsis tetrahit L.
  - var. bifida (Bönn) Lej. & Court.*
  - Hemp-nettle [y]
- Glechoma hederacea L.*
  - Ground-ivy [y]
- Hedeoma pulegioides (L.) Pers.
  - Mock-pennyroyal [ ]
- Leonurus cardiaca L.*
  - Motherwort [y]
- Lycopus americanus Muhl. ex Bart.
  - Water-horehound [y]
- Lycopus europaeus L.*
  - European water-horehound [ ]
- Lycopus uniflorus Michx.
  - Water-horehound [y]
- Lycopus virginicus L.
  - Water-horehound [n]
- Melissa officinalis L.*
  - Balm [ ]
- Mentha aquatica L.*
  - Peppermint [ ]
- Mentha arvensis L.*
  - Field mint [ ]
- Mentha canadensis L.
  - Field mint [ ]
- Mentha spicata L.*
  - Spearmint [ ]
- Moluccella laevis L.*
  - Mollucca-balm [n]
- Monarda fistulosa L.
  - Wild bergamot [y]
- Monarda punctata L.
  - Dotted horsemint [y]
- Monarda punctata L.
  - var. villicaulis (Pennell) Shinners
  - Dotted horsemint [ ]
- Nepeta cataria L.*
  - Catnip [y]
- Origanum vulgare L.*
  - Marjoram [ ]
- Physostegia virginiana (L.) Benth.
  - False dragon head [ ]
- Prunella vulgaris L.*
  - Self-heal [y]
- Pycnanthemum tenuifolium Schrad.
  - Mountain-mint [ ]
- Pycnanthemum virginianum (L.) Durieu & Jacks. ex Fern. & B. Robinson
  - Mountain-mint [y]
- Scutellaria galericulata L.
  - Common skullcap [y]
- Scutellaria lateriflora L.
  - Mad-dog skullcap [y]
- Stachys hyssopifolia Michx.
  - Hedge-nettle [n][C]

Stachys palustris L.*
Woundwort [ ]
Trichostema dichotomum L.
Blue-curls [y]

Boraginaceae
Anchusa officinalis L.*
Alkanet [ ]
Cynoglossum officinale L.*
Hound's-tongue [y]
Echium vulgare L.*
Blue-devil [y]
Hackelia virginiana (L.) Johnst.
Stickseed [y]
Lithospermum officinale L.*
European gromwell [y]
Myosotis arvensis (L.) Hill*
Forget-me-not [ ]
Myosotis laxa Lehm.
Wild forget-me-not [y]
Myosotis scorpioides L.*
Forget-me-not [y]
Onosmodium molle Michx.
ssp. hispidissimum (Mackz.) Boivin
Marble-seed [ ]
Onosmodium virginianum (L.) A. DC.
False gromwell [n]C

Verbenaceae
Verbena hastata L.
Blue vervain [y]
Verbena urticifolia L.
White vervain [y]

Plantaginaceae
Plantago lanceolata L.*
Buck-horn plantain [y]
Plantago major L.*
Common plantain [y]
Plantago patagonica Jacq.*
Plantain [n]
Plantago psyllium L.*
Whorled plantain [ ]
Plantago rugelii Dcne.
Pale plantain [y]

Scrophulariaceae
Agalinis tenuifolia (Vahl) Raf.
var. tenuifolia
Gerardia [y]
Aureolaria flava (L.) Farw.
var. flava
Yellow false-foxglove [ ]
Chaenorrhinum minus (L.) Lange*
Dwarf snapdragon [ ]
Chelone glabra L.
Turtle-heads [y]
Gratiola aurea Muhl.
Golden-pert [n]
Gratiola neglecta Torrey
Mud-hyssop [n]
Linaria canadensis (L.) Dumort.
Old-field toadflax [ ]
Linaria vulgaris Mill.*
Butter-and-eggs [y]
Lindernia dubia (L.) Pennell
False-pimpernel [ ]
Melampyrum lineare Desr.
Cow-wheat [y]
Mimulus ringens L.
Common monkeyflower [y]
Pedicularis canadensis L.
Lousewort [ ]
Penstemon hirsutus (L.) Willd.
Penstemon [y]
Schwalbea americana L.
Chaffseed [n]C
Scrophularia lanceolata Pursh
Hare-figwort [ ]
Verbascum blattaria L.*
Moth-mullein [y]
Verbascum thapsus L.*
Mullein [y]
Veronica americana (Raf.) Schwein. ex Benth.
American speedwell [y]
Veronica anagallis-aquatica L.
Water speedwell [ ]
Veronica beccabunga L.*
Brooklime [ ]
Veronica chamaedrys L.*
Bird's-eye speedwell [ ]
Veronica longifolia L.*
Speedwell [ ]
Veronica officinalis L.*
Speedwell [y]
Veronica peregrina L.
Neckweed [ ]
Veronica scutellata L.
Marsh speedwell [y]
Veronica serpyllifolia L.
ssp. serpyllifolia*
Thyme-leaf speedwell [ ]

Bignoniaceae
Catalpa speciosa (Warder ex Barney) Engelm.*
Catalpa [y]

Oleaceae
- Fraxinus americana L.
  - White ash [y]
- Fraxinus nigra Marsh.
  - Black ash [ ]
- Fraxinus pennsylvanica Marsh.
  - Green ash [y]
- Ligustrum obtusifolium Sieb. & Zucc.*
  - Privet [ ]
- Syringa vulgaris L.*
  - Lilac [y]

Orobanchaceae
- Epifagus virginiana (L.) Bartr.
  - Beech-drops [y]
- Orobanche uniflora L.
  - One-flowered cancer-root [ ]

Lentibulariaceae
- Utricularia gibba L.
  - Cone-spur bladderwort [n]
- Utricularia macrorhiza LeConte
  - Common bladderwort [ ]

Campanulaceae
- Campanula rapunculoides L.*
  - Creeping bellflower [ ]
- Campanula rotundifolia L.
  - Harebell [y]
- Lobelia cardinalis L.
  - Cardinal-flower [n]
- Lobelia dortmanna L.
  - Water lobelia [ ]
- Lobelia inflata L.
  - Indian-tobacco [y]
- Lobelia siphilitica L.
  - Great lobelia [y]
- Lobelia spicata Lam.
  - Pale-spiked lobelia [ ]
- Triodanis perfoliata (L.) Nieuwl.*
  - Venus' looking-glass [y]

Rubiaceae
- Cephalanthus occidentalis L.
  - Buttonbush [y]
- Galium aparine L.
  - Bedstraw [y]
- Galium asprellum Michx.
  - Rough bedstraw [y]
- Galium boreale L.
  - Northern bedstraw [y]
- Galium circaezans Michx.
  - Wild-licorice [y]
- Galium palustre L.
  - Ditch bedstraw [y]
- Galium tinctorium (L.) Scop.
  - Bedstraw [y]
- Galium trifidum L.*
  - Bedstraw [y]
- Galium triflorum Michx.
  - Sweet-scented bedstraw [y]
- Mitchella repens L.
  - Partridge-berry [y]

Caprifoliaceae
- Diervilla lonicera Mill.
  - Bush honeysuckle [y]
- Linnaea borealis L.
  - ssp. longiflora (Torrey) Hultén
  - Twinflower [y]
- Lonicera canadensis Bartr.
  - Fly honeysuckle [y]
- Lonicera dioica L.
  - var. dioica
  - Wild honeysuckle [ ]
- Lonicera japonica Thunb.*
  - Japanese honeysuckle [y]
- Lonicera morrowii A. Gray*
  - Fly honeysuckle [y]
- Lonicera morrowii × tatarica*
  - Fly honeysuckle [y]
- Lonicera sempervirens L.
  - Trumpet honeysuckle [y]
- Lonicera tatarica L.*
  - Tartarian honeysuckle [y]
- Lonicera xylosteum L.*
  - Fly honeysuckle [ ]
- Sambucus canadensis L.
  - Black elderberry [y]
- Sambucus racemosa L.
  - ssp. pubens (Michx.) House
  - Red elderberry [y]
- Symphoricarpos albus (L.) Blake
  - var. laevigatus (Fern.) Blake
  - Snowberry [ ]
- Symphoricarpos orbiculatus Moench*
  - Coralberry [y]
- Triosteum perfoliatum L.
  - Tinker's-weed [ ]
- Viburnum acerifolium L.
  - Maple-leaf viburnum [y]
- Viburnum dentatum L.
  - Southern arrowwood [y]
- Viburnum dentatum L.
  - var. lucidum Ait.
  - Southern arrowwood [y]
- Viburnum lantanoides Michx.
  - Hobblebush [y]
- Viburnum lentago L.
  - Sheepberry [y]

Viburnum nudum L.
var. nudum
Possom-haw [n]
Viburnum nudum L.
var. cassinoides (L.) Torrey & A. Gray
Wild raisin [y]C
Viburnum opulus L.
var. opulus*
Guelder-rose [ ]
Viburnum opulus L.
var. americanum Ait.
Highbush cranberry [y]
Viburnum rafanesquianum Schultes
Downy arrowwood [ ]

Valerianaceae
Valeriana officinalis L.*
Common valerian [ ]
Valerianella umbilicata (Sulliv.) Wood
Beaked corn-salad [ ]C

Dipsacaceae
Dipsacus fullonum L.*
Teasel [y]

Asteraceae
Achillea millefolium L.
var. millefolium
Common yarrow [y]
Ambrosia artemisiifolia L.
Ragweed [y]
Ambrosia psilostachya DC.*
Western ragweed [y]
Ambrosia trifida L.
Giant ragweed [y]
Anaphalis margaritacea (L.) Benth. & Hooker f. ex Clarke
Pearly-everlasting [y]
Antennaria neglecta Greene
ssp. neglecta
Everlasting [y]
Antennaria neglecta Greene
ssp. neodioica (Greene) Bayer
Smaller cat's-foot [ ]
Antennaria plantaginifolia (L.) Richards.
Everlasting [y]
Anthemis cotula L.*
Mayweed [ ]
Arctium minus (Hill) Bernh.*
Common burdock [y]
Artemisia absinthium L.*
Absinthe [ ]
Artemisia biennis Willd.*
Sage-weed [ ]

Aster acuminatus Michx.
Mountain aster [ ]
Aster cordifolius L.
Blue wood aster [y]
Aster divaricatus L.
White wood aster [y]
Aster ericoides L.
White wreath aster [y]
Aster infirmus Michx.
Cornel-leaved aster [y]
Aster laevis L.
Smooth blue aster [y]
Aster lanceolatus Willd.
var. simplex (Willd.) A. Jones
Old-field aster [ ]
Aster lateriflorus (L.) Britt.
Calico aster [y]
Aster linariifolius L.
Stiff-leaf aster [y]
Aster macrophyllus L.
Bigleaf aster [ ]
Aster novae-angliae L.
New England aster [y]
Aster novi-belgii L.
var. novi-belgii
New York aster [ ]
Aster novi-belgii
var. tardiflorus (L.) A. Jones
Late-flowering New York aster [ ]
Aster patens Ait.
Late purple aster [y]
Aster paternus Cronq.
White-topped aster [y]
Aster pilosus Willd.
Heath aster [ ]
Aster praealtus Poir.
Willow aster [ ]
Aster prenanthoides Muhl. ex Willd.
Zig-zag aster [y]
Aster puniceus L.
Purple-stemmed aster [y]
Aster schreberi Nees
Large-leaf aster [ ]
Aster umbellatus Mill.
Flat-top white aster [y]
Aster undulatus L.
Wavy-leaf aster [y]
Bidens cernua L.
Stick-tights [y]
Bidens connata Muhl. ex Willd
Beggar-ticks [ ]
Bidens frondosa L.
Beggar-ticks [y]
Bidens tripartita L.*
Beggar-ticks [y]

Bidens vulgata Greene
Beggar-ticks [y]
Calendula officinalis L.*
Pot-marigold [ ]
Centaurea cyanus L.*
Bluebottle [ ]
Centaurea jacea L.*
Brown knapweed [ ]
Centaurea maculosa Lam.*
Spotted knapweek, bushy knapweed [y]
Centaurea paniculata L.*
Knapweed [ ]
Cichorium intybus L.*
Chicory [y]
Cirsium arvense (L.) Scop.*
Canada thistle [y]
Cirsium discolor (Muhl. ex Willd.) Spreng.
Field-thistle [ ]
Cirsium muticum Michx.
Swamp-thistle [y]
Cirsium pumilum (Nutt.) Spreng.
Small bull-thistle [ ]
Cirsium vulgare (Savi) Tenore*
Bull-thistle [y]
Conyza canadensis (L.) Cronq.
var. canadensis
Horseweed [y]
Coreopsis grandiflora Hogg ex Sweet*
Coreopsis [ ]
Coreopsis lanceolata L.*
Coreopsis [y]
Cosmos bipinnatus Cav.*
Cosmos [ ]
Crepis biennis L.*
Hawk's-beard [ ]
Crepis tectorum L.*
Hawk's-beard [y]
Erechtites hieracifolia (L.) Raf. ex DC.
var. hieracifolia
Fireweed [y]
Erigeron annuus (L.) Pers.
Daisy-fleabane [y]
Erigeron philadelphicus L.
Fleabane [y]
Erigeron pulchellus Michx.
Robin's-plantain [ ]
Erigeron strigosus Muhl. ex Willd.
Daisy-fleabane [y]
Eupatorium coelestinum L.*
Mistflower [ ]
Eupatorium dubium Willd.
Joe-pye-weed [y]
Eupatorium fistulosum Barratt
Joe-pye-weed [y]
Eupatorium maculatum L.
Spotted Joe-pye-weed [y]
Eupatorium perfoliatum L.
Thoroughwort [y]
Eupatorium purpureum L.
Sweet Joe-pye-weed [ ]
Eupatorium rugosum Houtt.
White snakeroot [y]
Eupatorium sessilifolium L.
Upland boneset [ ]
Euthamia graminifolia (L.) Nutt. ex Cass.
Bush goldenrod [y]
Gaillardia aristata × pulchella*
Blanket-flower [ ]
Galinsoga quadriradiata Ruiz & Pavón*
Quickweed [ ]
Gnaphalium obtusifolium L.
Catfoot [ ]
Gnaphalium uliginosum L.*
Low cudweed [y]
Grindelia squarrosa (Pursh) Dunal*
Gumweed [ ]
Helenium autumnale L.
var. autumnale
Sneezeweed [y]
Helenium flexuosum Raf.*
Sneezeweed [ ]
Helianthus annuus L.*
Common sunflower [y]
Helianthus decapetalus L.
Thin-leaf sunflower [ ]
Helianthus divaricatus L.
Woodland sunflower [y]
Helianthus mollis Lam.*
Ashy sunflower [ ]
Helianthus petiolaris Nutt.*
Sunflower [ ]
Helianthus strumosus L.
Wood-sunflower [y]
Helianthus tuberosus L.*
Jerusalem artichoke [y]
Heliopsis helianthoides (L.) Sweet
Ox-eye [ ]
Hieracium aurantiacum L.*
Orange hawkweed [y]
Hieracium caespitosum Dumort.*
King-devil [y]
Hieracium floribundum Wimm. & Gräbn.
Smoothish hawkweed [ ]
Hieracium lachenalii Gmel.*
Hawkweed [ ]

Hieracium paniculatum L.
Hawkweed [y]
Hieracium pilosella L.*
Mouse-ear hawkweed [ ]
Hieracium piloselloides Vill.*
King-devil [ ]
Hieracium scabrum Michx.
Hawkweed [ ]
Hieracium venosum L.
Rattlesnake-weed [y]
Inula helenium L.*
Elecampane [ ]
Krigia virginica (L.) Willd.
Dwarf dandelion [y]
Lactuca biennis (Moench) Fern.
Wild lettuce [y]
Lactuca canadensis L.
Wild lettuce [y]
Lactuca serriola L.*
Prickly lettuce [y]
Leucanthemum vulgare Lam.*
Ox-eye daisy [y]
Liatris scariosa (L.) Willd.
var. novae-angliae Lunell
New England blazing-star [ ][C]
Matricaria discoidea DC.*
Pineapple-weed [y]
Petasites frigidus (L.) Fries
var. palmatus (Ait.) Cronq.
Sweet coltsfoot [ ]
Prenanthes alba L.
White lettuce [ ]
Prenanthes altissima L.
Rattlesnake-root [ ]
Prenanthes serpentaria Pursh
Lion's-foot [y]
Prenanthes trifoliolata (Cass.) Fern.
Gall-of-the-earth [y]
Ratibida columnifera (Nutt.) Wooton & Standl.*
Prairie coneflower [n]
Rudbeckia hirta L.
var. pulcherrima Farw.*
Black-eyed-Susan [y]
Rudbeckia laciniata L.
Cut-leaf coneflower [y]
Senecio aureus L.
Golden ragwort [y]
Senecio obovatus Muhl. ex Willd.
Ragwort [ ]
Solidago arguta Ait.
Cutleaf goldenrod [y]
Solidago bicolor L.
White goldenrod [y]
Solidago caesia L.
Wreath goldenrod [y]
Solidago canadensis L.
var. canadensis
Canada goldenrod [y]
Solidago canadensis L.
var. scabra (Muhl.) Torrey & A. Gray
Tall goldenrod [ ]
Solidago flexicaulis L.
Zig-zag goldenrod [y]
Solidago gigantea Ait.
Late goldenrod [y]
Solidago hispida Muhl. ex Willd.
Goldenrod [y]
Solidago juncea Ait.
Early goldenrod [y]
Solidago nemoralis Ait.
Rough goldenrod [y]
Solidago patula Muhl. ex Willd.
Spreading goldenrod [y]
Solidago puberula Nutt.
Downy goldenrod [ ]
Solidago rugosa Mill.
ssp. rugosa
Tall-hairy goldenrod [y]
Sonchus arvensis L.*
Sow-thistle [ ]
Sonchus asper (L.) Hill*
Spiny sow-thistle [y]
Sonchus oleraceus L.*
Sow-thistle [y]
Tanacetum vulgare L.*
Tansy [y]
Taraxacum officinale Weber ex Wiggers*
Common dandelion [y]
Tragopogon dubius Scop.*
Goat's-beard [y]
Tragopogon pratensis L.*
Yellow goat's-beard [y]
Tussilago farfara L.*
Coltsfoot [y]
Xanthium strumarium L.
Cocklebur [ ]

Alismataceae
Alisma subcordatum Raf.
Water-plantain [ ]
Alisma triviale Pursh
Water-plantain [ ]
Sagittaria cuneata Sheldon
Wapato [y]
Sagittaria latifolia Willd.
Wapato [y]
Sagittaria rigida Pursh
Arrowhead [ ]

Hydrocharitaceae
Elodea canadensis L. Rich. ex Michx.
Waterweed [y]

Najadaceae
Najas flexilis (Willd.) Rostk. & Schmidt
Naiad [n]
Najas gracillima (A. Br. ex Engelm.)
Magnus
Naiad [n]
Najas minor All.*
Naiad [ ]

Potamogetonaceae
Potamogeton crispus L.*
Pondweed [y]
Potamogeton epihydrus Raf.
Pondweed [ ]
Potamogeton foliosus Raf.
Pondweed [y]
Potamogeton natans L.
Pondweed [y]
Potamogeton nodosus Poir.
Pondweed [y]
Potamogeton pectinatus L.
Sago pondweed [ ]
Potamogeton perfoliatus L.
Pondweed [ ]
Potamogeton pusillus L.
Pondweed [ ]

Zannichelliaceae
Zannichellia palustris L.
Horned pondweed [n]

Araceae
Acorus americanus (Raf.) Raf.
Sweetflag [ ]
Arisaema triphyllum (L.) Schott ex
Schott & Endl.
ssp. stewardsonii (Britt.) Huttleston
Jack-in-the-pulpit [y]
Peltandra virginica (L.) Schott ex Schott
& Endl.
Arrowleaf [ ]
Symplocarpus foetidus (L.) Salisb. ex
Nutt.
Skunk-cabbage [y]

Lemnaceae
Lemna minor L.
Duckweed [y]
Lemna trisulca L.
Star duckweed [ ]
Spirodela polyrhiza (L.) Schleid.
Giant duckweed [y]
Wolffia borealis (Engelm.) Landolt
Watermeal [y]
Wolffia columbiana Karst.
Watermeal [y]

Commelinaceae
Commelina communis L.*
Dayflower [ ]
Tradescantia occidentalis (Britt.) Smyth*
Spiderwort [n]
Tradescantia ohiensis Raf.
Spiderwort [y]C
Tradescantia virginiana L.*
Spiderwort [y]

Xyridaceae
Xyris torta Sm.
Slender yellow-eyed grass [n]

Juncaceae
Juncus acuminatus Michx.
Sharp-fruited rush [y]
Juncus articulatus L.
Jointed rush [ ]
Juncus brevicaudatus (Engelm.) Fern.
Narrow-panicled rush [y]
Juncus bufonius L.
Toad-rush [y]
Juncus canadensis Gay ex LaHarpe
Canada rush [y]
Juncus dichotomus Ell.
var. platyphyllus Wieg.
Forked rush [y]
Juncus dudleyi Wieg.
Dudley's rush [ ]
Juncus effusus L.
Common rush [y]
Juncus greenei Oakes & Tuckerm.
Greene's rush [ ]
Juncus marginatus Rostk.
Grass-leaf rush [y]
Juncus nodosus L.
Knotted rush [n]
Juncus tenuis Willd.
Slender yard-rush [y]
Juncus torreyi Cov.
Torrey's rush [y]
Luzula campestris (L.) DC. in Lam.
& DC.
var. multiflora (Retz.) Lej.
Wood-rush [y]

Luzula campestris (L.) DC. in Lam. & DC.
var. pallescens (Wahl.) Wahl.
Common wood-rush [y]

Poaceae
Agrostis capillaris L.*
Colonial bent [y]
Agrostis gigantea Roth*
Redtop [y]
Agrostis hyemalis (Walt.) BSP.
Southern hairgrass [y]
Agrostis perennans (Walt.) Tuckerm.
Autumn bent [y]
Agrostis scabra Willd.
Hairgrass [y]
Agrostis stolonifera L.
var. palustris (Huds.) Farw.
Creeping bent [y]
Agrostis stolonifera L.
var. stolonifera
Creeping bent [ ]
Alopecurus aequalis Sobol.
Short-awn foxtail [y]
Andropogon gerardii Vitman
Big bluestem [y]
Anthoxanthum odoratum L.*
Sweet vernalgrass [ ]
Aristida dichotoma Michx.
Poverty-grass [ ]
Aristida oligantha Michx.*
Prairie three-awn [y]
Avena fatua L.
ssp. sativa (L.) Thell.*
Oats [ ]
Brachyelytrum erectum (Schreb. ex Spreng.) Beauv.
Bearded-shorthusk [ ]
Bromus arvensis L.*
Field chess [ ]
Bromus ciliatus L.
Fringed brome [ ]
Bromus commutatus Schrad.*
Hairy chess [ ]
Bromus inermis Leyss.*
Smooth brome [y]
Bromus japonicus Thunb. ex Murr.*
Japanese chess [y]
Bromus kalmii A. Gray
Brome [ ]
Bromus pubescens Muhl. ex Willd.*
Canada brome [y]
Bromus secalinus L.*
Cheat [ ]
Bromus tectorum L.*
Downy chess [y]
Calamagrostis canadensis (Michx.) Beauv.
var. canadensis
Bluejoint grass [y]
Calamagrostis stricta (Timm) Koeler
ssp. inexpansa (A. Gray) C. Greene
var. lacustris (Kearn.) C. Greene
Northern reed-grass [ ]
Cenchrus longispinus (Hack.) Fern.
Field sandbur [y]
Cinna arundinacea L.
Stout woodreed [y]
Cinna latifolia (Trev. ex Goepp.) Griseb.
Drooping woodreed [ ]
Dactylis glomerata L.*
Orchard grass [y]
Danthonia spicata (L.) Beauv. ex R. & S.
Poverty-grass [ ]
Deschampsia cespitosa L. Beauv.
Tufted hairgrass [ ]
Deschampsia flexuosa (L.) Trin.
Common hairgrass [y]
Digitaria cognatum (Schultes) Pilger
Fall witchgrass [ ]
Digitaria filiformis (L.) Koeler
Slender crabgrass [ ][C]
Digitaria ischaemum (Schreb. ex Schweig.) Schreb. ex Muhl.
Smooth crabgrass [y]
Digitaria sanguinalis (L.) Scop.*
Tall crabgrass [y]
Echinochloa crusgalli (L.) Beauv.
ssp. crusgalli*
Barnyard grass [y]
Echinochloa crusgalli (L.) Beauv.
ssp. edulis Hitchc.*
Japanese millet [ ]
Echinochloa muricata (Beauv.) Fern.
Cockspur grass [n]
Echinochloa muricata (Beauv.) Fern.
var. muricata
Cockspur grass [ ]
Echinochloa walteri (Pursh) Heller
Water-millet [y]
Elymus canadensis L.
Canada wild-rye [y]
Elymus hystrix L.
Bottlebrush [y]
Elymus riparius Wieg.
Marsh wild-rye [y]
Elymus villosus Muhl. ex Willd.
Wild-rye [ ]

Elymus virginicus L.
var. virginicus
Virginia wild-rye [y]
Elytrigia repens (L.) Nevski*
Quackgrass [ ]
Eragrostis capillaris (L.) Nees
Lacegrass [ ]
Eragrostis cilianensis (All.) Mosher*
Stinkgrass [y]
Eragrostis hypnoides (Lam.) BSP.
Lovegrass [ ]
Eragrostis minor Host*
Lovegrass [ ]
Eragrostis pectinacea (Michx.) Nees
Lovegrass [y]
Eragrostis spectabilis (Pursh) Steud.
Purple lovegrass [y]
Festuca elatior L.*
Tall fescue [y]
Festuca heterophylla Lam.*
Fescue [ ]
Festuca ovina L.*
Sheep fescue [y]
Festuca rubra L.
ssp. falax Thuill.*
Chewing's fescue [ ]
Festuca rubra L.
ssp. rubra*
Red fescue [ ]
Festuca subverticillata (Pers.) Alexc'ev
Nodding fescue [ ]
Festuca trachyphylla (Hackel) Krajina*
Sheep fescue [ ]
Glyceria acutiflora Torrey
Mannagrass [y]
Glyceria borealis (Nash) Batchelder
Northern mannagrass [n]
Glyceria canadensis (Michx.) Trin.
Rattlesnake grass [y]
Glyceria grandis S. Wats.
Reed meadowgrass [y]
Glyceria melicaria (Michx.) Hubb.
Slender mannagrass [y]
Glyceria melicaria × striata
Mannagrass [ ]
Glyceria striata (Lam.) Hitchc.
Fowl mannagrass [y]
Hordeum pusillum Nutt.
Little barley [y]
Leersia oryzoides (L.) Sw.
Rice cutgrass [y]
Leersia virginica Willd.
Whitegrass [ ]
Lolium perenne L.*
English ryegrass [y]
Lolium perenne L.
var. aristatum Willd.
Italian rye grass [ ]
Muhlenbergia frondosa (Poir.) Fern.
Wirestem muhly [y]
Muhlenbergia glomerata (Willd.) Trin.
Spike muhly [ ]
Muhlenbergia mexicana (L.) Trin.
Satin-grass [y]
Muhlenbergia schreberi Gmel.
Nimble-will [ ]
Muhlenbergia sylvatica (Torrey) Torrey ex A. Gray
Woodland drop-seed [ ]
Muhlenbergia tenuiflora (Willd.) BSP.
Woodland drop-seed [ ]
Oryzopsis asperifolia Michx.
Spreading ricegrass [y]
Oryzopsis pungens (Torrey ex Spreng.) Hitchc.
Ricegrass [ ]
Panicum acuminatum Sw.
Panic grass [y]
Panicum capillare L.
Witchgrass [y]
Panicum clandestinum L.
Deer-tongue [y]
Panicum depauperatum Muhl.
Poverty panic grass [y]
Panicum dichotomiflorum Michx.
Smooth panic grass [ ]
Panicum dichotomiflorum Michx.
var. dichotomiflorum
Smooth panic grass [ ]
Panicum dichotomum L.
Panic grass [y]
Panicum gattingeri Nash
Panic grass [ ]
Panicum latifolium L.
Panic grass [y]
Panicum linearifolium Scribn. ex Nash
Panic grass [ ]
Panicum ovale L.
Panic grass [ ]
Panicum philadelphicum Bernh. ex Trin.
Panic grass [ ]
Panicum rigidulum Bosc ex Nees
Panic grass [ ]
Panicum scabulorum Lam.
var. thinium (Hitchc. & Chase) C. Reed
Panic grass [y]
Panicum sphaerocarpon Ell.
Panic grass [ ]

Panicum villosissimum Nash
Panic grass [ ]
Panicum virgatum L.
var. spissum Linder
Switchgrass [y]
Panicum xanthophysum A. Gray
Panic grass [ ]
Paspalum setaceum Michx.
var. setaceum
Slender beardgrass [ ]C
Paspalum setaceum Michx.
var. stramineum (Nash) Banks
Slender beardgrass [ ]
Phalaris arundinacea L.
Reed canary-grass [n]
Phalaris canariensis L.*
Canary-grass [y]
Phleum pratense L.*
Timothy [y]
Phragmites australis (Cav.) Trin. ex Steud.*
Common reed [y]
Poa alsodes A. Gray
Speargrass [y]
Poa annua L.*
Annual bluegrass [y]
Poa compressa L.*
Canada bluegrass [y]
Poa languida Hitchc.
Woodland bluegrass [y]
Poa paludigena Fern. & Wieg.
Slender marsh bluegrass [y]C
Poa palustris L.
Fowl bluegrass [ ]
Poa pratensis L.*
Kentucky bluegrass [y]
Poa trivialis L.*
Rough bluegrass [ ]
Schizachyrium scoparium (Michx.) Nash
Little bluestem [y]
Secale cereale L.*
Rye [ ]
Setaria pumila (Poir.) Schultes*
Foxtail [y]
Setaria verticillata (L.) Beauv.*
Bur bristlegrass [ ]
Setaria viridis (L.) Beauv.
Green foxtail [y]
Sorghastrum nutans (L.) Nash ex Small
Indian grass [y]
Sphenopholis obtusata (Michx.) Scribn.
Prairie wedgegrass [ ]
Sporobolus neglectus Nash
Poverty-grass [ ]
Sporobolus vaginiflorus (Torrey ex A. Gray) Wood
Poverty-grass [ ]
Torreyochloa pallida (Torrey) Church
Pale mannagrass [ ]
Triticum aestivum L.*
Wheat [y]

Cyperaceae
Bulbostylis capillaris (L.) Clarke
Sand-rush [ ]
Carex amphibola Steud.
var. turgida Fern.
Sedge [y]
Carex annectens (Bickn.) Bickn.
Sedge [ ]
Carex appalachica Webber & Ball
Sedge [y]
Carex aquatilis Wahl.
Sedge [y]
Carex arctata Boott ex Hooker
Sedge [ ]
Carex atlantica Bailey
Sedge [ ]
Carex baileyi Britt.
Sedge [y]
Carex bebbii (Bailey) Olney ex Fern.
Sedge [y]
Carex blanda Dewey
Sedge [y]
Carex brevior (Dewey) Mackz. ex Lunell
Sedge [y]
Carex bromoides Schkuhr ex Willd.
Sedge [y]
Carex bushii Mackz.
Sedge [ ]
Carex buxbaumii Wahl.
Sedge [n]C
Carex canescens L.
Sedge [y]
Carex cephalophora Muhl. ex Willd.
Sedge [ ]
Carex comosa Boott
Sedge [y]
Carex complanata Torrey & Hooker
Sedge [ ]C
Carex conoidea Schkuhr ex Willd.
Sedge [ ]
Carex crinita Lam.
Sedge [y]
Carex cristatella Britt. ex Britt. & Brown
Sedge [y]
Carex cumulata (Bailey) Mackz.
Sedge [n]C

Carex debilis Michx.
var. rudgei Bailey
Sedge [ ]
Carex deweyana Schwein.
Sedge [y]
Carex disperma Dewey
Sedge [n]
Carex echinata Murr.
Sedge [ ]
Carex festucacea Schkuhr ex Willd.
Sedge [ ]
Carex foenea Willd.
Sedge [y]
Carex folliculata L.
Sedge [ ]
Carex gracilescens Steud.
Sedge [y]
Carex gracillima Schwein.
Sedge [y]
Carex granularis Muhl. ex Willd.
Sedge [ ]
Carex gynandra Schwein.
Sedge [y]
Carex hystericina Muhl. ex Willd.
Sedge [y]
Carex interior Bailey
Sedge [y]
Carex intumescens Rudge
Sedge [y]
Carex lacustris Willd.
Sedge [y]
Carex laevivaginata (Kük.) Mackz. ex Britt. & Brown
Sedge [y]
Carex lasiocarpa Ehrh.
ssp. americana (Fern.) Hultén
Sedge [n]
Carex laxiculmis Schwein.
Sedge [ ]
Carex laxiflora Lam.
Sedge [ ]
Carex leptalea Wahl.
Sedge [y]
Carex leptonervia (Fern.) Fern.
Sedge [ ]
Carex lupulina Muhl. ex Willd.
Sedge [y]
Carex lurida Wahl.
Sedge [y]
Carex muhlenbergii Schkuhr ex Willd.
var. muhlenbergii
Sedge [y]
Carex nigromarginata Schwein.
Sedge [ ][C]
Carex normalis Mackz.
Sedge [ ]
Carex pedunculata Muhl. ex Willd.
Sedge [y]
Carex pellita Muhl.
Sedge [ ]
Carex pensylvanica Lam.
Pennsylvania sedge [y]
Carex plantaginea Lam.
Plantain-sedge [ ]
Carex prairea Dewey ex Wood
Sedge [ ]
Carex projecta Mackz.
Sedge [y]
Carex pseudocyperus L.
Sedge [y]
Carex radiata (Wahl.) Small
Sedge [y]
Carex retrorsa Schwein.
Sedge [y]
Carex rosea Schkuhr ex Willd.
Sedge [y]
Carex rostrata Stokes ex With.
var. utriculata (Boott) Bailey
Sedge [n]
Carex rugosperma Mackz.
Sedge [y]
Carex scabrata Schwein.
Sedge [y]
Carex scoparia (L.) Schkuhr ex Willd.
Sedge [y]
Carex squarrosa L.
Sedge [ ]
Carex stipata Muhl. ex Willd.
Sedge [y]
Carex straminea Willd. ex Schkuhr
Sedge [y]
Carex stricta Lam.
Tussock sedge, hummock sedge [y]
Carex swanii (Fern.) Mackz.
Sedge [y]
Carex tenera Dewey
Sedge [y]
Carex tonsa (Fern.) Bickn.
Sedge [y]
Carex torta Boott & Tuckerm.
Sedge [y]
Carex tribuloides Wahl.
Sedge [y]
Carex trichocarpa Schkuhr ex Willd.
Sedge [y]
Carex trisperma Dewey
Sedge [n]
Carex tuckermanii Dewey
Sedge [ ]

Carex vaginata Taush
Sedge [ ]C
Carex vesicaria L.
Sedge [y]
Carex vestita Willd.
Sedge [y]
Carex vulpinoidea Michx.
Sedge [y]
Cyperus bipartitus Torrey
Flat sedge [y]
Cyperus diandrus Torrey
Cyperus [ ]
Cyperus erythrorhizos Muhl.
Cyperus [y]C
Cyperus esculentus L.*
Yellow nut-grass [ ]
Cyperus houghtonii Torrey
Flat sedge [y]C
Cyperus lupulinus (Spreng.) Marcks ssp. lupulinus
Flat sedge [y]C
Cyperus odoratus L.
Flat sedge [y]C
Cyperus schweinitzii Torrey
Flat sedge [y]C
Cyperus squarrosus L.
Cyperus [ ]
Cyperus strigosus L.
Galingale [y]
Dulichium arundinaceum (L.) Britt.
Three-way sedge [y]
Eleocharis acicularis (L.) R. & S.
Hairgrass [y]
Eleocharis elliptica Kunth
Slender spikerush [y]
Eleocharis erythropoda Steud.
Spikerush [y]
Eleocharis intermedia Schultes
Spikerush [y]
Eleocharis obtusa (Willd.) Schultes var. obtusa
Spikerush [y]
Eleocharis palustris (L.) R. & S.
Creeping spikerush [y]
Eriophorum tenellum Nutt.
Rough cottongrass [n]
Eriophorum virginicum L.
Tawny cottongrass [n]
Fimbristylis autumnalis (L.) R. & S.
Fimbry [y]
Rhynchospora alba (L.) Vahl
White beakrush [ ]
Scirpus acutus Muhl. ex Bigel.
Hard-stem bulrush [y]
Scirpus atrocinctus Fern.
Northern bulrush [y]
Scirpus atrovirens Willd.
Bulrush [y]
Scirpus cyperinus (L.) Kunth
Woolgrass [y]
Scirpus expansus Fern.
Bulrush [y]
Scirpus georgianus Harper
Bulrush [ ]C
Scirpus microcarpus Presl
Bulrush [y]
Scirpus polyphyllus Vahl
Leafy bulrush [n]
Scirpus tabernaemontani Gmel.
Soft-stem bulrush [y]
Scleria triglomerata Michx.
Nutrush [ ]C

Sparganiaceae
Sparganium americanum Nutt.
Bur-reed [y]
Sparganium erectum L.
Bur-reed [y]
Sparganium eurycarpum Engelm. ex A. Gray
Bur-reed [y]

Typhaceae
Typha angustifolia L.
Narrow-leaf cat-tail [y]
Typha angustifolia × latifolia
Cat-tail [y]
Typha latifolia L.
Common cat-tail [y]

Liliaceae
Allium canadense L.
Wild garlic [y]
Allium cepa L.*
Onion [ ]
Asparagus officinalis L.*
Asparagus [y]
Clintonia borealis (Ait.) Raf.
Wood lily [y]
Erythronium albidum Nutt.
White troutlily [ ]
Erythronium americanum Ker
Yellow adder's-tongue [y]
Hemerocallis fulva (L.) L.*
Orange day-lily [y]
Hemerocallis lilioasphodelus L.*
Yellow day-lily [y]
Hosta ventricosa (Salisb.) Stearn*
Blue hosta [y]

Hypoxis hirsuta (L.) Cov.
Stargrass [ ]
Lilium canadense L.
Canada lily [y]
Lilium philadelphicum L.
Wood lily [y]
Maianthemum canadense Desf.
False lily-of-the-valley [y]
Maianthemum racemosum L.
False Solomon's-seal [y]
Maianthemum stellatum L.
Starry false Solomon's seal, starflower [y]
Medeola virginiana L.
Indian cucumber-root [y]
Narcissus poeticus L.
var. recurvus (Haw.) Fernandez*
Poet's narcissus [ ]
Polygonatum pubescens (Willd.) Pursh
Solomon's-seal [y]
Streptopus roseus Michx.
Rose mandarin [y]
Trillium cernuum L.
Nodding trillium [y]
Trillium erectum L.
Purple trillium [ ]
Trillium grandiflorum (Michx.) Salisb.
White trillium [ ]
Trillium undulatum Willd.
Painted trillium [y]
Uvularia grandiflora Sm.
Bellwort [y]
Uvularia perfoliata L.
Strawbell [y]
Uvularia sessilifolia L.
Wild-oats [y]
Veratrum viride Ait.
False or white hellebore [y]

Iridaceae
Iris pseudacorus L.
Yellow iris [y]
Iris versicolor L.
Blue flag [y]
Sisyrinchium angustifolium Mill.
Blue-eyed grass [ ]
Sisyrinchium montanum Greene
Blue-eyed grass [y]

Pontederiaceae
Pontederia cordata L.
Pickerel-weed [ ]

Smilacaceae
Smilax herbacea L.
Jacob's-ladder [y]

Orchidaceae
Arethusa bulbosa L.
Swamp pink [n]C
Calopogon tuberosus (L.) BSP.
Grass pink [n]
Corallorhiza trifida Chat.
Pale coral-root [ ]
Cypripedium acaule Ait.
Pink ladyslipper [y]
Cypripedium reginae Walt.
Showy ladyslipper [ ]
Epipactis helleborine (L.) Crantz*
Helleborine [y]
Galearis spectabilis (L.) Raf.
Showy orchis [ ]
Goodyera pubescens (Willd.) R. Br.
Downy rattlesnake-plantain [ ]
Goodyera tesselata Lodd.
Rattlesnake plantain [ ]
Isotria verticillata (Muhl. ex Willd.) Raf.
Large whorled pogonia [ ]
Liparis loesellii (L.) L. Rich.
Bog twayblade [y]
Malaxis bayardii Fern.
Adder's-mouth [y]C
Platanthera ciliaris (L.) Lindl.
Orange orchid [ ]C
Platanthera clavellata (Michx.) Luer
Green woodland orchid [ ]
Platanthera dilatata (Pursh) Lindl. ex Beck
Bog-candle [ ]
Platanthera hookeri (Torrey ex A. Gray) Lindl.
Hooker's orchid [ ]C
Platanthera lacera (Michx.) G. Don
Ragged fringed orchid [y]
Platanthera orbiculata (Pursh) Lindl.
Round-leaved orchid [ ]
Platanthera psycodes (L.) Lindl.
Purple fringed orchid [y]
Pogonia ophioglossoides (L.) Juss.
Rose pogonia [ ]
Spiranthes cernua (L.) L. Rich.
Nodding lady's-tresses [y]
Spiranthes lacera (Raf.) Raf.
Slender lady's-tresses [ ]
Spiranthes ochroleuca (Rydb. ex Britt.) Rydb.
Creamy lady's tresses [y]

**Statistical summary**

128 plant families
487 genera
1,218 total plant taxa (species, subspecies, and varieties)
749 taxa (61.5%) confirmed (judged to be extant in the Albany Pine Bush)
46 taxa (3.8%) probably extirpated
423 taxa (34.7%) uncertain
903 native taxa (74.1% of the total), 578 confirmed
315 nonnative taxa (25.9% of the total), 171 confirmed
42 species of conservation interest, 13 confirmed, 10 probably extirpated

# Appendix C

## Insect Species List

**Class Insecta: Order Coleoptera**

The following list of eight tiger beetles from the Albany Pine Bush is based on a list presented by McCabe (1993). An early record of the northeastern beach tiger beetle, *Cicindela dorsalis* Say, is almost certainly an error, as this species is restricted to seacoasts, where adults prey on small invertebrates and scavenge dead fish in the intertidal zone. The species marked with a superscript X ($^{X}$) is thought to be extirpated from the Albany Pine Bush.

Cicindelidae
- Cicindela duodecimguttata Dejean
- Cicindela formosa Say
- Cicindela patruela Dejean$^{X}$
- Cicindela punctulata Olivier
- Cicindela repanda Dejean
- Cicindela scutelaris Say
- Cicindela sexguttata Fabricius
- Cicindela tranquebarica Herbst

The following list of 76 longhorned beetles from the Albany Pine Bush is based on a list published by McCabe and Huether (1986). Nomenclature has been rectified with that found in Yanega (1996). The list is probably incomplete, and further collecting could add names of previously unrecorded species. However, before this list was first published in 1986, none of the species had been recorded from the Pine Bush. The elderberry longhorned beetle, *Desmocerus palliatus*, has declined markedly in Massachusetts, where it is now regarded as a species of special concern. The reasons for the apparent decline are unknown.

Cerambycidae (Aseminae)
- Arhopalus rusticus obsoletus (Randall)
- Asemum striatum (Linnaeus)

Cerambycidae (Cerambycinae)
- Aneflomorpha subpubescens (LeConte)
- Anelaphus villosus (Fabricius)
- Batyle suturalis suturalis (Say)
- Clytus ruricola (Olivier)
- Cyrtophorus verrucosus (Olivier)
- Euderces picipes (Fabricius)
- Megacyllene robiniae (Forster)
- Molorchus bimaculatus bimaculatus Say
- Neoclytus acuminatus acuminatus (Fabricius)
- Parelaphidion incertum (Newman)
- Phymatodes aereus (Newman)
- Phymatodes amoenus (Say)
- Phymatodes testaceus (Linnaeus)
- Psyrassa unicolor (Randall)
- Xylotrechus sagittatus sagittatus (Germar)

Cerambycidae (Lamiinae)
- Acanthocinus obsoletus (Olivier)
- Aegomorphus modestus (Gyllenhal)
- Astylopsis macula (Say)
- Astylopsis sexguttata (Say)
- Ecyrus dasycerus dasycerus (Say)
- Eupogonius tomentosus (Haldeman)
- Goes debilis LeConte
- Goes pulcher (Haldeman)
- Hebestola nebulosa (Haldeman)
- Hippopsis lemniscata (Fabricius)
- Hyperplatys apsersa (Say)
- Lepturges angulatus (LeConte)
- Lepturges confluens (Haldeman)
- Lepturges pictus (LeConte)
- Liopinus alpha (Say)
- Monochamus notatus (Drury)

Monochamus scutellatus scutellatus (Say)
Monochamus titillator (Fabricius)
Oberea ocellata Haldeman
Oberea perspicillata Haldeman
Oberea tripunctata (Swederus)
Psenocerus supernotatus (Say)
Saperda calcarata Say
Saperda candida Fabricius
Saperda imitans Felt and Joutel
Saperda inornata Say
Saperda lateralis Fabricius
Saperda obliqua Say
Saperda tridentata Olivier
Saperda vistita Say
Sternidius variegatus (Haldeman)
Tetraopes melanurus Schönherr
Tetraopes tetraophthalmus (Forster)
Tetrops praeusta (Linnaeus)
Urgleptes signatus (LeConte)

Cerambycidae (Lepturinae)
Acmaeops discoideus (Haldeman)
Analeptura lineola (Say)
Brachyleptura champlaini Casey
Brachyleptura circumdata (Olivier)
Brachyleptura vagans (Olivier)
Brachypeptura rubrica (Say)
Charisalia americana (Haldeman)
Desmocerus palliatus (Forster)
Gaurotes cyanipennis (Say)
Grammoptera haematites (Newman)
Grammoptera subargentata (Kirby)
Judolia cordifera (Olivier)
Leptura subhamata Randall
Metacmoeops vittata (Swederus)
Pidonia ruficollis (Say)
Rhagium inquisitor (Linnaeus)
Strangalepta abbreviata (Germar)
Strangalia luteicornis (Fabricius)
Strophiona nitens (Forster)
Trachysida mutabilis (Newman)
Typocerus velutinus velutinus (Olivier)

Cerambycidae (Prioninae)
Orthosoma brunneum (Forster)
Prionus laticullis (Drury)
Prionus pocularis Dalmeister

**Class Insecta: Order Diptera**

The following list of 36 robber fly species from the Albany Pine Bush is based on a list compiled by McCabe and Weber (1994). Species marked with a superscript X ($^{X}$) are thought to be extirpated from the Albany Pine Bush. The species marked with a superscript S ($^{S}$) is believed to be a pine barrens specialist or obligate.

Asilidae
Asilus erythrocnemius Hine
Atomosia puella (Wiedemann)
Ceraturgus cruciatus (Say)
Cerotainia macrocera (Say)
Cyrtopogon falto (Walker)
Cyrtopogon laphriformis Curran$^{X}$
Cyrtopogon lutatius (Walker)
Cyrtopogon maginalis Loew
Dioctria baumhaueri Meigen
Diogmites basalis (Walker)
Diogmites umbrinus (Loew)
Efferia aestuans (Linnaeus)
Holopogon guttulus (Wiedemann)
Laphria aktis McAtee
Laphria cinerea (Back)$^{S}$
Laphria divisor (Banks)
Laphria flavicollis Say
Laphria franciscana Bigot
Laphria index McAtee
Laphria posticata Say
Laphria sadales Walker
Laphria thoracica Fabricius
Laphria virginica (Banks)
Lasiopogon currani Cole and Wilcox
Lasiopogon terricola (Johnson)
Leptogaster flavipes Loew
Leptogaster glabrata (Wiedemann)
Machimus notatus (Wiedemann)
Machimus sadyates (Walker)
Machimus snowii (Hine)
Neoitamus flavofemoratus (Hine)
Neoitamus orphne (Walker)
Ommatius tibialis Say
Proctacanthus philadelphicus Macquart
Proctacanthus rufus Williston
Promachus bastardii (Macquart)$^{X}$

**Class Insecta: Order Trichoptera**

The following list of 57 caddisfly species from the Albany Pine Bush is based on lists published by McCabe (1980, 1986). Nomenclature and taxonomic arrangement have been updated to comply, in most cases, with *Nomina Insecta Nearctica.*

Arctopsychidae
- Parapsyche apicalis (Banks)

Brachycentridae
- Brachycentrus americanum (Banks)

Hydropsychidae
- Ceratopsyche slossonae (Banks)
- Diplectrona modesta Banks
- Hydropsyche betteni Ross
- Hydropsyche sp.

Lepidostomatidae
- Lepidostoma sp.

Leptoceridae
- Ceraclea flavus (Banks)
- Ceraclea resurgens (Walker)
- Mystaeides sepulchralis (Walker)
- Nectopsyche albidus (Walker)
- Nectopsyche sp.
- Oecetis cinerascens (Hagen)
- Oecetis sp. 1
- Oecetis sp. 2
- Triaenodes baris Ross
- Triaenodes ignitus (Walker)
- Triaenodes marginata Sibley
- Triaenodes tarda Milne

Limnephilidae
- Anabolia consocius (Walker)
- Caborius lyratus Ross
- Frenesia difficilis (Walker)
- Frenesia missa (Milne)
- Glyphotaelius hostilis Hagen
- Ironoquia lyrata (Ross)
- Ironoquia parvula (Banks)
- Ironoquia punctatissimus (Walker)
- Limnephilus canadensis Banks
- Limnephilus indivisus Walker
- Limnephilus ornatus Banks
- Limnephilus sericeus (Say)
- Limnephilus submonilifer Walker
- Liminiphilus sp.
- Nemotaulius hostilis (Hagen)
- Neophylax fuscus Banks
- Onocosmoecus quadrinotatus (Banks)
- Pseudostenophylax uniformis (Betten)
- Psychoglypha subborealis (Banks)
- Pycnopsyche circularis (Provancher)
- Pycnopsyche divergens (Walker)
- Pycnopsyche indiana (Ross)
- Pycnopsyche luculenta (Betten)
- Pycnopsyche guttifer (Walker)
- Pycnopsyche scabripennis (Rambur)
- Pycnopsyche sp.

Molannidae
- Molanna blenda Sibley
- Molanna sp.

Philopotamidae
- Chimarra aterrima Hagen

Phryganeidae
- Agrypnia colorata Hagen
- Agrypnia vestita (Walker)
- Banksiola crotchi Banks
- Banksiola dossuaria (Say)
- Oligostomis pardalis (Walker)
- Phryganea sayi Milne
- Ptilostomis ocellifera (Walker)

Polycentropodidae
- Polycentropus interruptus (Banks)

Rhyacophilidae
- Rhyacophila fuscula (Walker)

**Class Insecta: Order Lepidoptera**
by Tim L. McCabe, New York State Museum

In the following list of 101 butterflies and skippers from the Albany Pine Bush, nomenclature and classification, in large part, follow the *Check List of Lepidoptera of America North of Mexico* (Hodges et al. 1983). Common names are those found in the *Peterson Field Guide to Eastern Butterflies* (Opler and Malikul 1992). Species marked with a superscript X ($^{X}$) are thought to be extirpated from the Albany Pine Bush.

Hesperiidae (36 species)
- Achalarus lyciades Gey.
  - Hoary edge
- Amblyscirtes hegon Scudder
  - Pepper and salt skipper
- Amblyscirtes vialis Edwards
  - Roadside skipper
- Ancyloxypha numitor F.
  - Least skipper
- Atrytone delaware Edwards
  - Delaware skipper
- Atrytonopsis hianna Scudder
  - Dusted skipper
- Calpodes ethlius Stoll (stray, last recorded in 1893)
  - Brazilian skipper
- Epargyreus clarus Cramer
  - Silver-spotted skipper
- Erynnis baptisiae Forbes
  - Wild indigo dusky wing
- Erynnis brizo Bdv. & Leconte$^{X}$
  - Sleepy dusky wing
- Erynnis icelus Scudder & Burgess
  - Dreamy dusky wing
- Erynnis juvenalis F.
  - Juvenal's dusky wing
- Erynnis lucilius Scudder & Burgess$^{X}$
  - Columbine dusky wing
- Erynnis martialis Scudder
  - Mottled dusky wing
- Erynnis persius Scudder$^{X}$
  - Persius dusky wing
- Euphyes bimacula G. & R.
  - Two-spotted skipper
- Euphyes conspicuus Edwards
  - Black dash
- Euphyes dion Edwards
  - Dion skipper
- Euphyes vestris Bdv.
  - Dun skipper
- Hesperia leonardus Harr.
  - Leonard's skipper
- Hesperia metea Scudder
  - Cobweb skipper
- Hesperia sassacus Harr.
  - Indian skipper
- Pholisora catullus F.
  - Common sooty wing
- Poanes hobomok Harr.
  - Hobomok skipper
- Poanes massasoit Scudder
  - Mulberry wing skipper
- Poanes viator zizaniae Shapiro
  - Broad-winged skipper
- Polites coras Cramer
  - Peck's skipper
- Polites mystic Edwards
  - Long dash
- Polites origenes F.
  - Crossline skipper
- Polites themistocles Latr.
  - Tawny-edged skipper
- Pompeius verna Edwards
  - Little glassywing
- Pyrgus communis Grt. (migrant; new record)
  - Checkered skipper
- Thorybes bathyllus J. E. Smith
  - Southern cloudy wing
- Thorybes pylades Scudder
  - Northern cloudy wing
- Thymelicus lineola Ochs. (European introduction)
  - European skipper
- Wallengrenia egeremet Scudder
  - Northern broken dash

Papilionidae (6 species)
- Battus philenor L. (stray; Corning Collection: Lintner 1890)
  - Pipe-vine swallowtail
- Papilio canadensis R. & J.
  - Canadian swallowtail
- Papilio cresphontes Cramer (stray; Lintner 1894)
  - Giant swallowtail
- Papilio glaucus L.
  - Tiger swallowtail
- Papilio polyxenes F.
  - Black swallowtail
- Papilio troilus L.
  - Spicebush swallowtail

Pieridae (9 species)
- Colias eurytheme Bdv.
  - Alfalfa butterfly
- Colias interior Scudder[X]
  - Pink-edged sulphur (last recorded in 1884)
- Colias philodice Godart
  - Clouded sulphur
- Eurema lisa Bdv. & Leeonte (migrant)
  - Little sulphur
- Phoebis sennae L. (migrant; new record)
  - Cloudless sulphur
- Pieris napi L.[X]
  - Mustard white
- Pieris rapae L.
  - Cabbage butterfly
- Pieris virginiensis Edwards[X]
  - West Virginia butterfly
- Pontia protodice Bdv. & Leconte[X]
  - Checkered white

Lycaenidae (18 species)
- Celastrina ladon ladon Cramer
  - Spring azure
- Celastrina ladon lucia Kby.
  - Spring azure
- Everes comyntas Godt.
  - Eastern tailed blue
- Feniseca tarquinius F.
  - Harvester
- Harkenclenus titus F.
  - Coral hairstreak
- Incisalia augustinus Kby.
  - Brown elfin
- Incisalia henrici G. & R.
  - Henry's elfin
- Incisalia irus Godt.
  - Frosted elfin
- Incisalia niphon Hbn.
  - Eastern pine elfin
- Lycaeides melissa samuelis Nabokov
  - Karner blue
- Lycaena hyllus Cramer
  - Bronze copper
- Lycaena phlaeas L.
  - American copper
- Satyrium acadicum Edwards
  - Acadian hairstreak
- Satyrium calanus Hbn.
  - Banded hairstreak
- Satyrium caryaevorum McD.
  - Hickory hairstreak
- Satyrium edwardsii G. & R.
  - Edwards' hairstreak
- Satyrium liparops Leconte
  - Striped hairstreak
- Strymon melinus Hbn.
  - Gray hairstreak

Nymphalidae (25 species)
- Boloria bellona F.
  - Meadow fritillary
- Boloria selene D. & S.
  - Silver-bordered fritillary
- Chlosyne harrisii Scudder
  - Harris checkerspot
- Chlosyne nycteis Doubleday
  - Silvery checkerspot
- Euphydryas phaeton Drury
  - Baltimore
- Euptoieta claudia Cramer (migrant; Corning Collection: Lintner 1890)
  - Variegated fritillary
- Junonia coenia Hbn. (migrant; Corning Collection: Lintner 1890)
  - Buckeye
- Limenitis archippus Cramer
  - Viceroy
- Limenitis arthemis arthemis Drury
  - Banded purple
- Limenitis arthemis astyanax Fabricius
  - Red-spotted purple
- Nymphalis antiopa L.
  - Mourning cloak
- Nymphalis milberti Godt. (stray; new record)
  - Milbert's tortoise shell
- Nymphalis urticae L. (European introduction)
  - Small tortoise shell
- Nymphalis vau-album D. & S.
  - Compton tortoise shell
- Phyciodes batesii Reakirt[X]
  - Tawny crescent
- Phyciodes tharos Drury
  - Pearl crescent
- Polygonia comma Harr.
  - Hop merchant
- Polygonia interrogationis F.
  - Question mark
- Polygonia progne Cramer
  - Gray comma
- Speyeria aphrodite F.
  - Aphrodite fritillary
- Speyeria cybele Fabricius
  - Great spangled fritillary
- Speyeria idalia Drury[X]
  - Regal fritillary
- Vanessa atalanta L. (migrant)
  - Red admiral
- Vanessa cardui Linnaeus (migrant)
  - Painted lady

Vanessa virginiensis Drury (migrant)
American painted lady

Satyridae (6 species)
Cercyonis pegala Fabricius
Common wood nymph
Coenonympha inornata Edwards
Inornate ringlet
Enodia anthedon A. H. Clark
Northern pearly eye
Megisto cymela Cramer
Little wood satyr
Satyrodes appalachia R. Chermock
Appalachian eyed brown
Satyrodes eurydice Johansson
Eyed brown

Danaidae (1 species)
Danaus plexippus L. (migrant)
Monarch

In the following list of Albany Pine Bush moths, nomenclature follows that found in the *Check List of the Lepidoptera of America North of Mexico* (Hodges et al. 1983), unless the name is a recent combination or recently described species. Geometrid nomenclature follows Scoble (1999). Species marked with a superscript X ($^{X}$) have not been found in the course of intensive collecting effort over the past 25 years. Species marked with a superscript R ($^{R}$) are known in the Pine Bush only from recent collecting, during the past 25 years. Species marked with a superscript S ($^{S}$) are believed to be pine barrens specialists or obligates, dependent on characteristic vegetation, sandy and arid environments, periodic fires, or some other ecological characteristic of the Pine Bush for their continued existence in this area.

Zygaenidae (3 species)
Acoloithus falsarius Clem.
Harrisina americana Guér.
Pyromorpha dimidiata H.-S.$^{X}$

Megalopygidae (1 species)
Lagoa crispata Pack.$^{X}$

Thyrididae (2 species)
Thyris maculata Harr.
Thyris sepulchralis Guér.

Thyatiridae (3 species)
Euthyatira pudens Gn.
Habrosyne scripta Gosse
Pseudothyatira cymatophoroides Gn.

Drepanidae (4 species)
Drepana arcuata Wlk.
Drepana bilineata Pack.
Eudeilinia herminiata Gn.
Oreta rosea Wlk.

Geometridae (165 species)
Aethalura intertexta Wlk.
Alsophila pometaria Harr.
Anavitrinella pampinaria Gn.
Antepione thisoaria Gn.
Anticlea vasiliata Gn.
Anticlea multiferata Wlk.
Apodrepanulatrix liberaria Wlk.
Archiearis infans Moesch.$^{X}$
Besma quercivoraria Gn.
Biston betularia L.
Cabera erythemaria Gn.
Cabera variolaria Gn.
Campaea perlata Gn.
Caripeta divisata Wlk.
Caripeta piniata Pack.
Cepphis decoloraria Hulst
Cepphis armataria H.-S.
Chlorochlamys chloroleucaria Gn.
Cingilia catenaria Drury$^{X}$
Cladara limitaria Wlk.
Cladara angulineata G. & R.
Cladara atroliturata Wlk.
Costiconvexa centrostrigaria Woll.
Cyclophora pendulinaria Gn.
Dichorda iridaria Gn.
Dyspteris abortivaria H.-S.
Dysstroma citrata L.
Dysstroma hersiliata Gn.
Ecliptopera silaceata D. & S.
Ectropis crepuscularia D. & S.
Ematurga amitaria Gn.
Ennomos magnaria Gn.
Ennomos subsignaria Hbn.
Ephirrhoe alternata Mueller
Erannis tiliaria Harr.
Erastria coloraria F.
Eubaphe mendica Wlk.
Euchlaena serrata Drury
Euchlaena muzaria Wlk.
Euchlaena johnsonaria Fitch
Euchlaena marginaria Minot
Euchlaena tigrinaria Gn.

Euchlaena irraria B. & McD.
Eufidonia notataria Wlk.
Eugonobapta nivosaria Gn.
Eulithis diversilineata Hbn.
Eulithis testata L.
Eulithis explantata Wlk.
Eumacaria latiferrugata Wlk.
Euphyia unangulata Haw.
Eupithecia albicapitata Pack.
Eupithecia lariciata Freyer
Eupithecia miserulata Grt.
Eupithecia ravocostaliata Pack.
Eusarca confusaria Hbn.
Eutrapela clemataria J. E. Smith
Glena cribrataria Gn.
Gueneria similaria Wlk.
Haematopis grataria F.
Heliomata cycladata G. & R.
Hesperumia suphuraria Pack.
Heterophleps triguttaria H.-S.
Homochlodes fritillaria Gn.
Horisme intestinata Gn.
Hydrelia condensata Wlk.
Hydrelia albifera Wlk.
Hydriomena perfracta Swett
Hydriomena divisaria Wlk.
Hydriomena transfigurata Swett
Hydriomena pluviata Gn.
Hypagyrtis unipunctata Haw.
Idaea bonifata Hulst
Idaea demissaria Hbn.
Idaea dimidiata Hufn.
Iridopsis vellivolata Hulst
Iridopsis humaria Gn.
Iridopsis larvaria Gn.
Lambdina fiscellaria Gn.
Lobophora nivigerata Wlk.
Lobophora montanata Pack.
Lomographa semiclarata Wlk.
Lomographa vestaliata Gn.
Lomographa glomeraria Grt.
Lycia ursaria Wlk.
Lytrosis unitaria H.-S.
Macaria aemulataria Hulst
Macaria ulsterata Pears.
Macaria transitaria Wlk.
Macaria minorata Pack.
Macaria bicolorata F.
Macaria bisignata Wlk.
Macaria pinistrobata Ferg.
Macaria granitata Gn.
Macaria ocellinata Gn.
Macaria mellistrigata Grt.
Macaria gnophosaria Gn.
Melanolophia canadaria Gn.
Mesoleuca ruficillata Gn.
Mesothea incertata Wlk.
Metanema inatomaria Gn.
Metanema determinata Wlk.
Metarranthis duaria Gn.
Metarranthis angularia B. & McD.
Metarranthis indeclinata Wlk.
Metarranthis hypochraria H.-S.
Metarranthis apiciaria Pack.[X]
Metarranthis obfirmaria Hbn.
Micaria pustularia Gn.
Micaria ribearia Fitch
Micaria evagaria Hulst
Micaria argillacearia Pack.
Micaria n. sp.
Nematocampa resistaria H.-S.
Nemoria bistriaria Hbn.
Nemoria rubrifrontaria Pack.
Nemoria mimosaria Gn.
Nepytia canosaria Wlk.
Nepytia semiclusaria Wlk.[X]
Operophtera bruceata Hulst
Orthofidonia flavivenata Hulst
Orthonama obstipata F.
Paleacrita vernata Peck
Patalene olyzonaria Wlk.
Pero honestaria Wlk.
Pero morrisonaria Hy. Edw.
Pero ancetaria Hbn.
Petrophora subaequaria Wlk.
Phaeoura quernaria Smith
Phigalia titea Cramer
Phigalia strigataria Minot
Plagodis pulveraria L.
Plagodis serinaria H.-S.
Plagodis kuetzingi Grt.
Plagodis phlogosaria Gn.
Plagodis fervidaria H.-S.
Plagodis alcoolaria Gn.
Pleuroprucha insulsaria Gn.
Probole alienaria H.-S.
Probole amicaria H.-S.
Prochoerodes lineola Goeze
Protitame virginalis Hulst
Rheumaptera prunivorata Ferg.
Rheumaptera hastata L.
Scopula limboundata Haw.
Scopula quadrilineata Pack.
Scopula siccata McD.
Scopula inductata Gn.
Selenia alciphearia Wlk.
Sicya macularia Harr.
Spargania magnoliata Gn.
Spodolepis substriataria Hulst
Synchlora aerata F.

Tacparia detersata Gn.
Tetracis crocallata Gn.
Tetracis cachexiata Gn.
Thera juniperata L.
Trichodezia albovittata Gn.
Triphosa haesitata Gn.
Venusia duodecemlineata Pack.
Venusia comptaria Wlk.
Xanthorhoe labradorensis Pack.
Xanthorhoe ferrugata Cl.
Xanthorhoe lacustrata Gn.
Xanthotype urticaria Swett
Xanthotype sospeta Drury

Epiplemidae (2 species)
Calledapteryx dryopterata Grt.
Callizzia amorata Pack.

Mimallonidae (1 species)
Lacosoma chiridota Grt.

Apatelodidae (2 species)
Apatelodes torrefacta J. E. Smith
Olceclostera angelica Grt.

Lasiocampidae (6 species)
Artace cribraria Ljungh[X]
Malacosoma americanum F.
Malacosoma disstria Hbn.
Phyllodesma americana Harr.
Tolype laricis Fitch
Tolype velleda Stoll

Saturniidae (12 species)
Actias luna L.
Anisota senatoria J. E. Smith
Anisota virginiensis Drury
Antheraea polyphemus Cramer
Automeris io F.
Callosamia promethea Drury
Citheronia regalis F.[X]
Citheronia sepulcralis G. & R.[X]
Dryocampa rubicunda F.
Eacles imperialis Drury[X]
Hemileuca maia Drury
Hyalophora cecropia L.

Sphingidae (36 species)
Agriuscingulatus F. (stray individuals)
Amphion floridensis B. P. Clark
Ceratomia amyntor Geyer
Ceratomia catalpae Bdv.
Ceratomia undulosa Wlk.
Darapsa myron Cram.
Darapsa pholus Cram.
Darapsa versicolor Harr.[X]
Deidamia inscripta Harr.
Dolba hyloeus Drury
Eumorpha achemon Drury
Eumorpha pandorus Hbn.
Hemaris diffinis Bdv.
Hemaris gracilis G. & R.[X]
Hemaris thysbe F.
Hyles gallii Rottemburg (European introduction)
Hyles lineata F. (migrant)
Laothoe juglandis J. E. Smith
Laparabombycoides Wlk.
Laparaconiferarum J. E. Smith
Manduca quinquemaculata Haw.
Manduca sexta L.
Pachysphinx modesta Harr.
Paonias astylus Drury[X]
Paonias excaecatus J. E. Smith
Paonias myops J. E. Smith
Smerinthus cerisyi Kby.
Smerinthus jamaicensis Drury
Sphecodina abbottii Swainson
Sphinx chersis Strkr.
Sphinx eremitus Strkr.
Sphinx canadensis Bdv.
Sphinx drupiferarum J. E. Smith
Sphinx kalmiae J. E. Smith
Sphinx luscitiosa Clem.
Sphinx poecila Stephens

Notodontidae (46 species)
Cerura scitiscripta Wlk.
Clostera albosigma Fitch
Clostera apicalis Wlk.
Clostera inclusa Hbn.
Clostera strigosa Grt.
Dasylophia anguina J. E. Smith
Dasylophia thyatiroides Wlk.
Datana integerrima G. & R.[X]
Datana ministra Drury[X]
Ellida caniplaga Wlk.
Furcula borealis Guér.-Méneville
Furcula cinerea Wlk.
Furcula modesta Hudson
Furcula scolopendrina Bdv.
Gluphisia avimacula Hudson
Gluphisia lintneri Grt.
Gluphisia septentrionis Wlk.
Heterocampa biundata Wlk.
Heterocampa guttivitta Wlk.
Heterocampa obliqua Pack.
Hyparax aurora J. E. Smith
Hyperaeschra georgica H.-S.
Lochmaeus bilineata Pack.

Lochmaeus manteo Doubleday
Macrurocampa marthesia Cram.
Misogada unicolor Pack.
Nadata gibbosa J. E. Smith
Nerice bidentata Wlk.
Notodonta scitipennis Wlk.
Notodonta simplaria Graef
Odontosia elegans Stkr.
Oligocentria lignicolor Wlk.
Oligocentria semirufescens Wlk.
Peridea angulosa J. E. Smith
Peridea basitriens Wlk.
Peridea ferruginea Pack.
Pheosia rimosa Pack.
Schizura apicalis G. & R.
Schizura badia Pack.
Schizura concinna J. E. Smith
Schizura ipomoeae Doubleday
Schizura leptinoides Grt.
Schizura unicornis J. E. Smith
Symmerista albifrons J. E. Smith
Symmerista canicosta Francl.
Symmerista leucitys Francl.

Arctiidae (39 species)
Apantesis nais Drury
Apantesis phalerata Harr.
Cisseps fulvicollis Hbn.
Clemensia albata Pack.
Crambidia pallida Pack.
Ctenucha virginica Esp.
Cycnia oregonensis Stretch
Cycnia tenera Hbn.
Ecpantheria scribonia Stoll[X]
Eilema bicolor Grt.[X]
Estigmene acrea Drury
Euchaetes egle Drury
Grammia arge Drury
Grammia celia Saunders
Grammia parthenice W. Kby.
Grammia phyllira Drury
Grammia virgo L.
Grammia virguncula W. Kby.
Halysidota tessellaris Sm.
Haploa confusa Lyman
Haploa lecontei Guér.-Méneville
Haploa clymene Brown
Holomelina aurantiaca Hbn.
Holomelina ferruginosa Wlk.
Holomelina laeta Guér.-Méneville
Holomelina opella Grt.
Hyphantria cunea Drury
Hypoprepia fucosa Hbn.
Hypoprepia miniata Kby.
Lophocampa caryae Harr.
Lophocampa maculata Harr.
Lycomorpha pholus Drury
Phragmatobia assimilans Wlk.[X]
Phragmatobia fuliginosa L.
Pyrrharctia isabella J. E. Smith
Spilosoma congrua Wlk.
Spilosoma dubia Wlk.
Spilosoma latipennis Stretch
Spilosoma virginica F.

Lymantriidae (11 species)
Dasychira basiflava Pack.
Dasychira dorsipennata (B. & McD.)
Dasychira obliquata G. & R.
Dasychira pinicola Dyar
Dasychira plagiata Wlk.
Dasychira vagans B. & McD.
Leucoma salicis L.
Lymantria dispar L.
Orgyia antiqua L.
Orgyia definita Pack.
Orgyia leucostigma J. E. Smith

Noctuidae (563 species)
Abagrotis alternata Grt.
Abagrotis cupida Grt.[S]
Abrostola ovalis Gn.[R]
Abrostola urentis Gn.
Achatia distincta Hbn.
Achatodes zeae Harr.
Acronicta albarufa Grt.[S]
Acronicta clarescens Gn.
Acronicta connecta Grt.[X]
Acronicta dactylina Grt.
Acronicta falcula Grt.[S]
Acronicta fragilis Gn.
Aeronicta grisea Wlk.
Acronicta hamamelis Gn.
Acronicta hasta Gn.
Acronicta hastulifera J. E. Smith
Acronicta impressa Wlk.
Acronicta increta Morr.
Acronicta innotata Gn.
Acronicta interrupta Gn.
Acronicta laetifica Sm.
Acronicta lanceolaria Grt.[SX]
(disappeared around 1991)
Acronicta leporina L.
Acronicta lepusculina Gn.
Acronicta lithospila Grt.
Acronicta lobeliae Gn.
Acronicta longa Gn.
Acronicta modica Wlk.
Acronicta morula G. & R.
Acronicta noctivaga Grt.

Acronicta oblinita J. E. Smith
Acronicta ovata Grt.
Acronicta pruni Harr.[X] (last found in the 1880s)
Acronicta radcliffei Harv.[SX]
Acronicta retardata Wlk.
Acronicta sperata Grt.[S]
Acronicta spinigera Gn.[S]
Acronicta subochrea Grt.
Acronicta superans Gn.
Acronicta tristis Sm.[S]
Acronicta tritona Hbn.
Acronicta vinnula Grt.
Actebia fennica Tauscher
Adita chionanthi J. E. Smith
Agnorisma badinodis Grt.
Agriopodes fallax H.-S.
Agroperina lutosa Andrews[X] (last found in 1876)
Agrotis gladiaria Morr.
Agrotis ipsilon Hufn.
Agrotis stigmosa Morr.[R]
Agrotis subterranea F.[R] (migrant)
Agrotis venerabilis Wlk.
Agrotis volubilis Harv.[S]
Alabama argillacea Hbn. (migrant)
Aletia oxygala Grt.
Allagrapha aerea Hbn.
Allotria elonympha Hbn.[X]
Alypia octomaculata F.
Amolita fessa Grt.
Amolita roseola Sm.[R]
Amphipoea americana Speyer
Amphipoea interoceanica Sm.
Amphipoea velata Wlk.
Amphipyra glabella Morr.
Amphipyra pyramidoides Gn.
Amphipyra tragopoginis Cl.
Amyna octo Gn. (migrant)
Anagrapha falcifera Kby.
Anaplectoides prasina D. & S.
Anaplectoides pressus Grt.
Anathix puta G. & R.
Anathix ralla G. & R.
Anicla infecta Ochs. (migrant)
Anorthodes tarda Gn.[R] (first seen in 1995)
Anticarsia gemmatalis Hbn. (migrant)
Apamea alia Gn.
Apamea amputatrix Fitch
Apamea apamiformis Gn.
Apamea burgessi Morr.[X]
Apamea cariosa Gn.
Apamea cristata Grt.
Apamea devastator Brace
Apamea dubitans Wlk.
Apamea helva Grt.
Apamea impulsa Gn.
Apamea lignicolora Gn.
Apamea nigrior Sm.
Apamea ophiogramma Grt.[R] (recent European introduction)
Apamea plutonia Grt.
Apamea remissa Hbn.
Apamea sordens Hufn.
Apamea verbascoides Gn.
Apamea vultuosa Grt.
Apharetra dentata Grt.[S]
Aplectoides condita Gn.
Archanara laeta Morr.
Archanara oblonga Grt.
Archanara subflava Grt.
Argyrostrotis anilis Drury
Argyrostrotis quadrifilaris Hbn. (collected in 1879, then again in 1995)
Ascalapha odorata L.[X] (tropical migrant)
Athetis miranda Grt.
Autographa ampla Wlk.
Autographa precationis Gn.
Bagisara rectifascia Grt.
Baileya dormitans Gn.
Baileya doubledayi Gn.
Baileya levitans Sm.
Baileya ophthalmica Gn.
Balsa labecula Grt.
Balsa malana Fitch
Balsa tristrigella Wlk.
Bellura obliqua Wlk.
Bleptina caradrinalis Gn.
Brachylomia discinigra Wlk.
Caenurgina crassiuscula Haw.
Caenurgina erechtea Cram.
Callopistria cordata Ljungh
Callopistria mollissima Gn.
Calophasia lunula Hufn.[R] (recent European introduction)
Calyptra canadensis Bethune
Capis curvata Grt.
Caradrina meralis Morr.[S]
Caradrina multifera Wlk.
Catabena lineolata Wlk.
Catocala amatrix Hbn.
Catocala amica Hbn.
Catocala andromedae Gn.
Catocala antinympha Hbn.
Catocala blandula Hulst
Catocala briseis Edw.
Catocala cara Gn.
Catocala cerogama Gn.
Catocala clintoni Grt.[X]

Catocala coccinata Grt.
Catocala concumbens Wlk.
Catocala connubialis Gn.
Catocala crataegi Saunders
Catocala gracilis Edw.[S]
Catocala grynea Cram.
Catocala habilis Grt.
Catocala ilia Cram.
Catocala judith Strkr.
Catocala lineella Grt.
Catocala meskei Grt.
Catocala micronympha Gn.
Catocala mira Grt.
Catocala neogama J. E. Smith
Catocala n. sp. (near jair Stkr.)
Catocala palaeogama Gn.
Catocala parta Gn.
Catocala piatrix Grt.
Catocala praeclara G. & R.
Catocala pretiosa Lint.[X] (last recorded in 1877)
Catocala relicta Wlk.
Catocala residua Grt.
Catocala retecta Grt.
Catocala similis Edw.[S]
Catocala sordida Grt.[S]
Catocala subnata Grt.
Catocala ultronia Hbn.
Catocala unijuga Wlk.
Catocala vidua J. E. Smith
Catocala whitneyi Dodge[X]
Celiptera frustulum Gn.
Cerastis fishii Grt.
Cerastis salicarum Wlk.
Cerastis tenebrifera Wlk.
Cermacerintha Tr.
Cerma cora Hbn.[S]
Chaetaglaea cerata Francl.[S]
Chaetaglaea sericea Morr.
Chaetaglaea tremula Harv.[S]
Charadra deridens Gn.
Chersotis juncta Grt.
Chrysanympha formosa Grt.[S]
Chytolita morbidalis Gn.
Chytolita petrealis Grt.
Chytonix palliatricula Gn.
Chytonix sensilis Grt.[S]
Cirrhophanus triangulifer Grt.[SX]
Cissusa spadix Cram.[S]
Colobochyla interpuncta Grt.[S]
Colocasia flavicornis Sm.
Colocasia propinquilinea Grt.
Condica vecors Gn.
Condica videns Gn.
Conservula anodonta Gn.
Copivaleria grotei Morr.
Cosmia calami Harv.
Crambodes talidiformis Gn.
Crocigrapha normani Grt.
Cryptocala acadiensis Bethune[X]
Cucullia asteroides Gn.
Cucullia convexipennis G. & R.
Cucullia lucifuga D. & S.
Cucullia omissa Dod
Cucullia postera Gn.
Cucullia speyeri Lint.[S]
Deltote albidula Gn.
Deltote bellicula Hbn.
Deltote muscosula Gn.
Deltote musta G. & R.
Diachrysia aereoides Grt.
Diachrysia balluca Gey.
Diarsia jucunda Wlk.[X]
Diarsia rubifera Grt.[X]
Discestra trifolii Hufn.
Dypterygia rozmani Berio
Dyspyralis illocata Warren[S]
Dyspyralis nigella Stkr.
Dyspyralis puncticosta Sm.
Egira dolosa Grt.
Elaphria festivoides Gn.
Elaphria grata Hbn.
Elaphria versicolor Grt.
Enargia decolor Wlk.
Enargia infumata Grt.
Enargia mephisto Francl.
Eosphoropteryx thyatyroides Gn.
Epiglaea apiata Grt.[SX]
Epiglaea decliva Grt.
Eremobina jocasta Smith
Euagrotis forbesi Francl.
Euagrotis illapsa Wlk.
Eucirroedia pampina Gn.
Euclidia cuspidea Hbn.
Eudryas grata F.
Eudryas unio Hbn.
Eueretagrotis attenta Grt.
Eueretagrotis perattenta Grt.
Eueretagrotis sigmoides Gn.
Eugraphe subrosea opacifrons Grt.[X]
Euparthenos nubilis Hbn.
Euplexia benesimilis McD.
Eupsilia devia Grt.
Eupsilia morrisoni Grt.
Eupsilia n. sp.
Eupsilia sidus Gn.[S]
Eupsilia tristigmata Grt.
Eupsilia vinulenta Grt.
Eurois occulta L.[X]
Eutolype rolandi Grt.

Euxoa albipennis Grt.
Euxoa bostoniensis Grt.
Euxoa campestris Grt.
Euxoa detersa Wlk.
Euxoa divergens Wlk.
Euxoa fumalis Grt.
Euxoa messoria Harr.
Euxoa mimallonis Grt.
Euxoa obeliscoides Gn.
Euxoa ochrogaster Gn.
Euxoa perpolita Morr.[X]
Euxoa redimicula Morr.
Euxoa scandens Riley
Euxoa tessallata Harr.
Euxoa velleripennis Grt.
Fagitana littera Gn.[X]
Faronta diffusa Wlk.
Feltia herilis Grt.
Feltia jaculifera Gn.
Feltia subgothica Haw.
Feltia tricosa Lint.
Feralia jocosa Gn.
Feralia major Sm.
Gabara subnivosella Wlk.[S]
Galgula partita Gn.
Graphiphora auger Fab.
Hadena capsularis Gn.
Harrisimemna trisignata Wlk.
Helicoverpa zea Boddie
Helotropha reniformis Grt.
Heptagrotis phyllophora Grt.
Himella fidelis Grt.[R]
Homoglaea hircina Morr.
Homohadena badistriga Grt.[S] (population declining since 1994)
Homohadena infixa Wlk.
Homophoberia apicosa Haw.
Homorthodes furfurata Grt.
Hydraecia immanis Gn.[X]
Hydraecia micacea Esp.[R] (recent European introduction)
Hypena abalienalis Wlk.
Hypena atomaria Sm.
Hypena baltimoralis Gn.
Hypena bijugalis Wlk.
Hypena deceptalis Wlk.
Hypena edictalis Wlk.
Hypena humuli Harr.
Hypena madefactalis Gn.
Hypena manalis Wlk.
Hypena palparia Wlk.
Hypena sordidula Grt.[X]
Hypenodes caducus Dyar
Hypenodes fractilinea Sm.
Hypenodes palustris Ferguson[R]
Hyperstrotia secta Grt.
Hyperstrotia villificans B. & McD.
Hypocoena inquinata Gn.
Hyppaxylinoides Gn.
Idia aemula Hbn.
Idia americalis Gn.
Idia concisa Wlk.
Idia denticulalis Harv.
Idia diminuendis B. & McD.
Idia forbesi French
Idia laurenti Sm.
Idia lubricalis Gey.
Idia rotundalis Wlk.
Idia scobialis Grt.
Ipimorpha pleonectusa Grt.
Lacanobia atlantica Grt.[R]
Lacanobia subjuncta G. & R.
Lacinipolia anguina Grt.
Lacinipolia lorea Gn.
Lacinipolia lustralis Grt.
Lacinipolia meditata Grt.
Lacinipolia olivacea Morr.
Lacinipolia renigera Steph.
Lascoria ambigualis Wlk.
Ledaea perditalis Wlk.
Lemmeria digitalis Grt.
Leucania adjuta Grt.
Leucania commoides Gn.
Leucania inermis Fbs.
Leucania insueta Gn.
Leucania lapidaria Grt.
Leucania linita Gn.
Leucania multilinea Wlk.
Leucania phragmatidicola Gn.
Leucania pseudargyria Gn.
Leucania ursula Fbs.
Leuconycta diphteroides Gn.
Leuconycta lepidula Grt.[X]
Lithomoia germana Morr.[X]
Lithophane amanda Sm.
Lithophane antennata Wlk.
Lithophane baileyi Grt.
Lithophane bethunei G. & R.
Lithophane disposita Morr.
Lithophane fagina Morr.
Lithophane georgii Grt.[X] (last recorded in 1877)
Lithophane grotei Riley
Lithophane hemina Grt.
Lithophane innominata Sm.
Lithophane laticinerea Grt.
Lithophane lepida Grt.[SX] (last recorded in 1877)
Lithophane oriunda Grt.
Lithophane patefacta Wlk.

Lithophane petulca Grt.
Lithophane pexata Grt.
Lithophane querquera Grt.[S]
Lithophane semiusta Grt.[X] (last recorded in 1877)
Lithophane thaxteri Grt.[SX] (last recorded in 1877)
Lithophane unimoda Lint.
Lomanaltes eductalis Wlk.
Luperina passer Gn.
Macrochilo absorptalis Wlk.
Macrochilo bivittata Grt.
Macrochilo hypocritalis Ferg.
Macrochilo litophora Grt.
Macrochilo louisiana Fbs.
Macrochilo orciferalis Wlk.
Macronoctua onusta Grt.
Magusa orbifera Wlk. (migrant)
Maliattha synochitis Gn.
Marathyssa basalis Wlk.
Marathyssa inficita Wlk.
Meganola minuscula Zell.
Meganola spodia Francl.[R]
Melanchra adjuncta Gn.
Melanchra assimilis Morr.
Melanchra picta Harr.
Melanogramma auricinctaria Grt.
Melaporphyria immortua Grt.[X]
Meropleon diversicolor Morr.
Metalectra discalis Grt.
Metalectra quadrisignata Wlk.
Metaxaglaea inulta Grt.
Metaxaglaea viatica Grt.
Mocis latipes Gn. (migrant)
Morrisonia confusa Hbn.
Morrisonia evicta Grt.
Morrisonia latex Gn.
Nedra ramosula Gn.
Nephelodes minians Gn.
Noctua pronuba L.[R] (recent European introduction)
Nola cilicoides Grt.
Nola ovilla Grt.
Nola pustulata Wlk.
Nola triquetrana Fitch
Nycteola frigidana Wlk.[X]
Ochropleura plecta L.
Ogdoconta cinereola Gn.
Oligia bridghami G. & R.
Oligia chlorostigma[R] Harv.
Oligia crytora Francl.
Oligia exhausta Sm.
Oligia fractilinea Grt.
Oligia illocata Wlk.
Oligia mactata Gn.
Oligia modica Gn.
Oligia obtusa Sm.[R]
Ophiuche abjuralis Wlk.
Orthodes crenulata Butler
Orthodes cynica Gn.
Orthosia alurina Sm.
Orthosia hibisci Gn.
Orthosia revicta Morr.
Orthosia rubescens Wlk.
Paectes oculatrix Gn.
Palthis angulalis Hbn.
Palthis asopialis Gn.
Pangrapta decoralis Hbn.
Panopoda carneicosta Gn.
Panopoda rufimargo Hbn.
Panthea acronyctoides Wlk.
Panthea furcilla Pack.
Papaipema n. sp.
Papaipema arctivorens Hamp.
Papaipema baptisiae Bird
Papaipema eupatorii Lyman
Papaipema furcata Sm.
Papaipema impecuniosa Grt.
Papaipema inquaesita G. & R.
Papaipema lysimachiae Bird[S]
Papaipema nebris Gn.
Papaipema nepheleptena Dyar
Papaipema pterisii Bird
Papaipema rigida Grt.
Papaipema unimoda Sm.
Parahypenodes quadralis B. & McD.[R]
Parallelia bistriaris Hbn.
Parascotia mineta Francl.[R]
Parastichtis suspecta Hbn.
Peridroma saucia Hbn.
Phalaenophana pyramusalis Wlk.
Phalaenostola eumelusalis Wlk.
Phalaenostola hanhami Sm.
Phalaenostola larentioides Grt.
Phalaenostola metonalis Wlk.
Phlogophora iris Gn.
Phlogophora periculosa Gn.
Phoberia atomaris Hbn.
Phoberia orthosioides Gn.
Phosphila miselioides Gn.[X]
Plagiomimicus pityochromus Grt.[X]
Plathypena scabra F.
Platypolia anceps Steph.[SX]
Plusia contexta Grt.
Plusia putnami Grt.
Plusia venusta Wlk.
Plusiodonta compressipalpis Gn.
Polia detracta Wlk.
Polia goodelli Grt.
Polia imbrifera Gn.

Polia nimbosa Gn.
Polia purpurissata Grt.
Polygrammate hebraeicum Hbn.
Polypogon cruralis Gn.
Polypogon laevigata Grt.
Polypogon lituralis Hbn.
Polypogon martha Barnes[S]
Polypogon n. sp.
Polypogon ochreipennis Grt.
Polypogon pedipilalis Gn.
Polypogon protumnusalis Wlk.
Protolampra brunneicollis Grt.
Protolampra rufipectus Morr.[X]
Protorthodes oviduca Gn.
Psaphida resumens Wlk.
Psectraglaea carnosa Grt.[SX] (last recorded in 1881)
Pseudaletia unipuncta Haw.
Pseudeustrotia carneola Gn.
Pseudeva purpurigera Wlk.
Pseudohermonassa bicarnea Gn.
Pseudoplusia includens Wlk.
Pseudorthodes vecors Gn.
Psychomorpha epimenis Drury
Pyreferra ceromatica Grt.[X] (last recorded in 1877)
Pyreferra citrombra Francl.[R]
Pyreferra hesperidago Gn.
Pyreferra pettiti Grt.[S]
Pyrrhia adela Laf. & Mik.
Pyrrhia exprimens Wlk.
Raphia frater Grt.
Redectis vitrea Grt.
Renia discoloralis Gn.
Renia flavipunctalis Gey.
Renia salusalis Wlk.
Rhizedra lutosa Hbn.[R] (recent European introduction)
Rivula propinqualis Gn.
Schinia arcigera Gn.
Schinia florida Gn.
Schinia jaguarina Gn.
Schinia lynx Gn.
Schinia nundina Drury
Schinia rivulosa Gn.
Schinia septentrionalis Wlk.
Schinia tuberculum Hbn.
Scolecocampa liburna Geyer
Scoliopteryx libatrix L.
Sideridis congermana Morr.[S]
Sideridis maryx Gn.[S]
Sideridis rosea Harv.
Simyra henrici Grt.
Spaelotis clandestina Harr.
Spargaloma sexpunctata Grt.
Spartiniphaga includens Wlk.
Spartiniphaga panatela Sm.
Spiramater grandis Gn.
Spiramater lutra Gn.
Spotoptera exigua Hbn. (migrant)
Spodoptera frugiperda J. E. Smith (migrant)
Spodoptera ornithogalli Gn. (migrant)
Sunira bicolorago Gn.
Sutyna privata Wlk.
Synedoida grandirena Haw.[R]
Syngrapha abstrusa Eichlin
Syngrapha rectangula W. Kby.
Tarachidia candefacta Hbn.
Tarachidia erastrioides Gn.
Thysania zenobia Cram.[X] (migrant)
Trachaea delicata Grt.
Tricholita signata Wlk.
Trichoplusia ni Hbn.
Trichordestra legitima Grt.
Trichordestra lilacina Harv.[X]
Trichosilia geniculata G. & R.
Ufeus plicatus Grt.[R]
Ufeus satyricus Grt.[X]
Ulolonche culea Gn.
Ulolonche modesta Morr.
Xanthia n. sp. (nr. togata Esp.)
Xestia adela Francl.
Xestia badicollis Grt.[X]
Xestia dilucida Morr.
Xestia dolosa Francl.
Xestia elimata Gn.[RS]
Xestia normaniana Grt.
Xestia smithii Snellen
Xylena cineritia Grt.[S] (not seen since 1980s)
Xylena curvimacula Morr.
Xylena nupera Lint.
Xylena thoracica Putnam-Cramer[X]
Xylomoia chagnoni B. & McD.
Xylotype capax Grt.[SX] (last recorded 1877)
Xystopeplus rufago Hbn.[S]
Zale aeruginosa Gn.
Zale curema Sm.[S]
Zale duplicata Bethune
Zale galbanata Morr.
Zale helata Sm.
Zale horrida Hbn.
Zale lunata Drury (migrant)
Zale lunifera Hbn.[R]
Zale metatoides McD.[SX]
Zale minerea Gn.
Zale obliqua Gn.[S]
Zale phaeocapna Francl.[R S]

Zale submediana Strand[S]
Zale undularis Drury
Zale unilineata Grt.

**Class Insecta: Order Hymenoptera**

The following list of 33 ant species from the Albany Pine Bush is extracted from the work of Dolores Savignano (1990, 1994). Additional information was provided by Dr. Ryk P. Spoor, Albany College of Pharmacy, and Dr. Stephan Cover, Museum of Comparative Zoology, Harvard University.

Formicidae (Formicinae)
- Camponotus americanus Mayr
- Camponotus novaeboracensis (Fitch)
- Camponotus pennsylvanicus (DeGeer)
- Formica difficilis Emery
- Formica exsectoides Forel
- Formica lasioides Emery
- Formica querquetulana Kennedy and Dennis
- Formica subsericea Say
- Formica incerta Emery
- Formica nitidiventris Emery
- Formica schaufussi Mayr
- Lasius alienus (Foerster)
- Lasius neoniger Emery
- Paratrechina parvula (Mayr)
- Polyergus lucidus Mayr
- Prenolepis imparis (Say)

Formicide (Myrmicinae)
- Acanthomyops interjectus (Mayr)
- Aphaenogaster rudis (Emery)
- Aphaenogaster treatae Forel
- Crematogaster cerasi (Fitch)
- Crematogaster lineolata (Say)
- Iridomyrmex pruinosus (Roger)
- Leptothorax ambiguus Emery
- Monomorium emarginatum DuBois
- Myrmica americana Weber
- Myrmica fracticornis Emery
- Myrmica pinetorum Wheeler
- Pheidole pilifera (Roger)
- Solenopsis molesta (Say)
- Tetramorium caespitum (Linnaeus)

Formicidae (Dolichoderinae)
- Dolichoderus plagiatus (Mayr)
- Dolichoderus taschenbergi (Mayr)
- Tapinoma sessile (Say)

# Appendix D

## Fishes Species List

The following list of 30 Pine Bush fish species is taken from *The Pine Bush Intermunicipal Study* (Bristol, Litynski, Wojcik, P.C. 1980). The taxonomic arrangement and nomenclature follow Smith (1985).

**Class Osteichthyes: Order Anguilliformes**
Anguillidae
Anguilla rostrata (Lesueur)
American eel *Blockhouse Creek, Hunger Kill, Kaikout Kill, Stuyvesant Plaza Pond*

**Class Osteichthyes: Order Siluriformes**
Ictaluridae
Ictalurus natalis (Lesueur)
Yellow bullhead *Lake Rensselaer, Lisha Kill*
Ictalurus nebulosus (Lesueur)
Brown bullhead *Stuyvesant Plaza Pond, Lake Rensselaer, Lisha Kill, Glass Pond*

**Class Osteichthyes: Order Cypriniformes**
Catostomidae
Catostomus catostomus (Forster)
Longnose sucker *Lake Rensselaer*
Catostomus commersoni (Lacepède)
White sucker *Glass Pond, Hunger Kill, Lisha Kill, East Branch Hunger Kill*
Cyprinidae
Carassius auratus (Linnaeus) (introduced from eastern Asia, China)
Goldfish *Glass Pond, East Branch Hunger Kill, Lisha Kill*
Cyprinus carpio Linnaeus (introduced from Europe, temperate Asia)
Common carp *Lisha Kill, Lake Rensselaer*
Notemigonus crysoleucas (Mitchill)
Golden shiner *Lake Rensselaer, Stuyvesant Plaza Pond, Glass Pond*
Rhinichthys atratulus (Hermann)
Eastern blacknose dace *Lisha Kill, East Branch Hunger Kill*
Rhinichthys cataractae (Valenciennes)
Longnose dace *Lisha Kill*
Semotilus atromaculatus (Mitchill)
Creek chub *Lisha Kill*
Semotilus margarita (Cope)
Pearl dace *Glass Pond, East Branch Hunger Kill*
Notropis cornutus (Mitchill)
Common shiner *Glass Pond, Lisha Kill*
Pimephales notatus (Rafinesque)
Bluntnose minnow *Lisha Kill*
Pimephales promelas Rafinesque
Fathead minnow *Glass Pond*

**Class Osteichthyes: Order Salmoniformes**
Salmonidae
Salmo trutta Linnaeus (introduced from Europe, western Asia)
Brown trout *Hunger Kill*
Salvelinus fontinalis (Mitchill)
Brook trout *Glass Pond, Hunger Kill, Kaikout Kill*
Esocidae
Esox lucius Linnaeus
Northern pike *Lake Rensselaer* (stocked)

**Class Osteichthyes: Order Atheriniformes**
Cyprinodontidae
Fundulus diaphanus (Lesueur)
Banded killfish *Hunger Kill, Glass Pond*

**Class Osteichthyes: Order Perciformes**
Centrarchidae
Ambloplites rupestris (Rafinesque)
Rock bass *Lisha Kill, Lake Rensselaer*
Lepomis gibbosus (Linnaeus)
Pumpkinseed *Lake Rensselaer, Glass Pond, Lisha Kill, Stuyvesant Plaza Pond*
Lepomis macrochirus Rafinesque
Bluegill *Lake Rensselaer, Lisha Kill*
Micropterus dolomieui Lacepède
Smallmouth bass *Lisha Kill, Lake Rensselaer* (stocked)
Micropterus salmoides (Lacepède)
Largemouth bass *Glass Pond, Lake Rensselaer, Lisha Kill, Stuyvesant Plaza Pond*
Pomoxis nigromaculatus (Lesueur)
Black crappie *Lake Rensselaer, Stuyvesant Plaza Pond*
Percidae
Etheostoma olmstedi Storer
Tessellated darter *Lisha Kill*
Perca flavescens (Mitchill)
Yellow perch *Lake Rensselaer, Lisha Kill, Stuyvesant Plaza Pond*
Percina caprodes (Rafinesque)
Logperch *Lisha Kill*
Stizostedion vitreum (Mitchill)
Walleye *Lake Rensselaer (stocked)*

**Class Osteichthyes: Order Scorpaeniformes**
Cottidae
Cottus cognatus Richardson
Slimy sculpin *East Branch Hunger Kill, Hunger Kill, Kaikout Kill*

# Appendix E

## Amphibians and Reptiles Species List

The list of amphibians and reptiles recorded from the Albany Pine Bush is derived from the work of Stewart and Rossi (1981) and named according to the Society for the Study of Amphibians and Reptiles' list of *Standard Common and Current Scientific Names for North American Amphibians and Reptiles* (Collins 1997). Stewart and Rossi's work was based on detailed study of museum specimens, literature records dating as far back as 1835, and personal observations of competent herpetologists from 1949 to 1977. Some additions have been made to the list since then. Several species listed here have not been found in more recent years (Hunsinger 1999).

**Class Amphibia: Order Caudata**

Ambystomatidae
- Ambystoma jeffersonianum (Green)
  - Jefferson salamander
- Ambystoma laterale Hallowell
  - Blue-spotted salamander
- Ambystoma maculatum (Shaw)
  - Spotted salamander

Plethodontidae
- Desmognathus fuscus (Green)
  - Northern dusky salamander
- Eurycea bislineata (Green)
  - Northern two-lined salamander
- Plethodon cinereus (Green)
  - Northern redback salamander

Salamandridae
- Notophthalamus viridescens viridescens (Rafinesque)
  - Red-spotted newt

**Class Amphibia: Order Anura**

Bufonidae
- Bufo americanus americanus Holbrook
  - Eastern American toad
- Bufo fowleri Hinckley
  - Fowler's toad

Hylidae
- Pseudacris crucifer (Wied-Neuwied)
  - Spring peeper
- Hyla versicolor LeConte
  - Gray treefrog

Pelobatidae
- Scaphiopus holbrookii (Harlan)
  - Eastern spadefoot

Ranidae
- Rana catesbeiana Shaw
  - Bullfrog
- Rana clamitans Latreille
  - Green frog
- Rana pipiens Schreber
  - Northern leopard frog
- Rana sylvatica LeConte
  - Wood frog

**Class Reptilia: Order Testudines**

Chelydridae
- Chelydra serpentina serpentina (Linnaeus)
  - Common snapping turtle

Kinosternidae
- Sternotherus odoratus (Latreille)
  - Common musk turtle

Emydidae
- Chrysemys picta (Schneider)
  - Painted turtle
- Clemmys guttata (Schneider)
  - Spotted turtle
- Clemmys insculpta (LeConte)
  - Wood turtle
- Terrapene carolina carolina (Linnaeus)
  - Eastern box turtle
- Trachemys scripta elegans (Wied-Neuwied)
  - Red-eared slider

**Class Reptilia: Order Squamata, Suborder Serpentes**

Colubridae
- Carphophis amoenus amoenus (Say)
  - Eastern worm snake
- Coluber constrictor constrictor (Linnaeus)
  - Northern black racer
- Elaphe obsoleta obsoleta (Say)
  - Black rat snake
- Heterodon platirhinos Latreille
  - Eastern hognose snake
- Lampropeltis triangulum triangulum (Lacépède)
  - Eastern milk snake
- Liochlorophis vernalis (Harlan)
  - Smooth green snake
- Nerodia sipedon sipedon (Linnaeus)
  - Northern water snake
- Storeria dekayi dekayi (Holbrook)
  - Northern brown snake
- Storeria occipitomaculata (Storer)
  - Redbelly snake
- Thamnophis sirtalis sirtalis (Linnaeus)
  - Eastern garter snake

# Appendix F

## Birds Species List

The list of birds recorded from the Albany Pine Bush was compiled by combining several published lists and ordering them according to The Federation of New York State Bird Clubs' *Checklist of the Birds of New York State* (1999). Lists of confirmed and probable breeders, adapted from the breeding bird Atlas project (Andrle and Carroll 1988), are found in Schneider et al. (1991). Caution should be exercised in using that list because bird atlas observation blocks are large and do not conform to the boundaries of the Albany Pine Bush. Some of the species might occur only in the vicinity of the Pine Bush, and not in the Pine Bush proper. The species designated here as permanent and summer residents or nonbreeding visitors or transients are listed in Miller (1976) and *The Pine Bush Intermunicipal Study* (Bristol, Litynski, Wojcik, P.C. 1980). Both references are based on D. J. Rothaupt and W. P. Chamberlain's (1980) extensive personal observations and compilations of bird club reports. Species designated as common were listed by Kerlinger and Doremus (1981a, 1981b). Brian Beachy (University at Albany) provided updated status reports on some species, based on extensive summer 2001 field observations. His annotations to this list are designated by the letters BB. It appears that reliable information on the avifauna of the previous two decades is virtually nonexistent.

**Class Aves: Order Podicipediformes**
Podicipedidae
Podilymbus podiceps (Linnaeus)
Pied-billed grebe (spring and fall transient)

**Class Aves: Order Ciconiiformes**
Ardeidae
Ardea herodias Linnaeus
Great blue heron (spring and fall transient)
Botaurus lentiginosus (Rackett)
American bittern (summer resident)
Butorides striatus (Linnaeus)
Green-backed heron (summer resident)

Cathartidae
Cathartes aura (Linnaeus)
Turkey vulture (spring and fall transient; BB: summer resident)

**Class Aves: Order Anseriformes**
Anatidae
Branta canadensis (Linnaeus)
Canada goose (spring and fall transient)
Aix sponsa (Linnaeus)
Wood duck (spring and fall transient)
Anas rubripes Brewster
American black duck (permanent resident)

Anas platyrhynchos Linnaeus
Mallard (permanent resident)
Anas discors Linnaeus
Blue-winged teal (spring and fall transient)
Anas acuta Linnaeus
Northern pintail (spring and fall transient)
Anas crecca Linnaeus
Green-winged teal (spring and fall transient)
Aythya collaris (Donovan)
Ring-necked duck (spring transient)
Mergus merganser Linnaeus
Common merganser (spring and fall transient)

**Class Aves: Order Falconiformes**
Accipitridae
Circus cyaneus (Linnaeus)
Northern harrier or marsh hawk (vagrant)
Accipiter striatus Vieillot
Sharp-shinned hawk (spring and fall transient)
Accipiter cooperii (Bonaparte)
Cooper's hawk (spring and fall transient)
Buteo lineatus (Gmelin)
Red-shouldered hawk (summer resident)
Buteo platypterus Vieillot
Broad-winged hawk (spring and fall transient)
Buteo jamaicensis (Gmelin)
Red-tailed hawk (permanent resident, probable breeder)
Buteo lagopus (Pontoppidan)
Rough-legged hawk (winter visitor)

Falconidae
Falco sparverius Linnaeus
American kestrel (permanent resident)
Falco peregrinus Tunstall
Peregrine falcon (vagrant)

**Class Aves: Order Galliformes**
Phasianidae
Phasianus colchicus Linnaeus
Ring-necked pheasant (permanent resident)
Bonasa umbellus (Linnaeus)
Ruffed grouse (permanent resident, confirmed breeder)
Meleagris gallopavo Linnaeus
Wild turkey (permanent resident)

Odontophoridae
Colinus virginianus (Linnaeus)
Northern bobwhite (permanent resident; BB: not observed)

**Class Aves: Order Gruiformes**
Rallidae
Rallus limicola Vieillot
Virginia rail (summer resident)

**Class Aves: Order Charadriiformes**
Charadriidae
Charadrius vociferus Linnaeus
Killdeer (summer resident, confirmed breeder)

Scolopacidae
Tringa flavipes (Gmelin)
Lesser yellowlegs (spring and fall transient)
Tringa solitaria Wilson
Solitary sandpiper (spring and fall transient)
Actitis macularia (Linnaeus)
Spotted sandpiper (summer resident)
Bartramia longicauda (Bechstein)
Upland sandpiper (summer visitor)
Calidris minutilla (Vieillot)
Least sandpiper (spring and fall transient)
Gallinago gallinago (Linnaeus)
Common snipe (summer resident)
Scolopax minor Gmelin
American woodcock (summer resident)

**Class Aves: Order Columbiformes**
Columbidae
Columba livia Gmelin
Rock dove (probable breeder)
Zenaida macroura (Linnaeus)
Mourning dove (permanent resident, confirmed breeder)

**Class Aves: Order Cuculiformes**
Cuculidae
Coccyzus erythrophthalmus (Wilson)
Black-billed cuckoo (summer resident)
Coccyzus americanus (Linnaeus)
Yellow-billed cuckoo (summer resident; BB: not observed)

**Class Aves: Order Strigiformes**
Strigidae
Otus asio (Linnaeus)
Eastern screech-owl (permanent resident)
Bubo virginianus (Gmelin)
Great horned owl (permanent resident, probable breeder)
Aegolius acadicus (Gmelin)
Northern saw-whet owl (vagrant)

**Class Aves: Order Caprimulgiformes**
Caprimulgidae
Chordeiles minor (Forster)
Common nighthawk (summer resident)
Caprimulgus vociferus Wilson
Whip-poor-will (summer resident, probable breeder)

**Class Aves: Order Apodiformes**
Apodidae
Chaetura pelagica (Linnaeus)
Chimney swift (summer resident)

Trochilidae
Archilochus colubris (Linnaeus )
Ruby-throated hummingbird (summer resident)

**Class Aves: Order Coraciiformes**
Alcedinidae
Ceryle alcyon (Linnaeus)
Belted kingfisher (summer resident)

**Class Aves: Order Piciformes**
Picidae
Melanerpes erythrocephalus (Linnaeus)
Red-headed woodpecker (vagrant)
Sphyrapicus varius (Linnaeus)
Yellow-bellied sapsucker (spring and fall transient)
Picoides pubescens (Linnaeus)
Downy woodpecker (permanent resident, probable breeder)
Picoides villosus (Linnaeus)
Hairy woodpecker (permanent resident)
Picoides arcticus (Swainson)
Black-backed woodpecker (winter visitor)
Colaptes auratus (Linnaeus)
Northern flicker (summer resident, probable breeder)
Dryocopus pileatus (Linnaeus)
Pileated woodpecker (permanent resident, probable breeder)

**Class Aves: Order Passeriformes**
Tyrannidae
Contopus borealis (Swainson)
Olive-sided flycatcher (summer visitor)
Contopus virens (Linnaeus)
Eastern wood-pewee (summer resident)
Empidonax flaviventris (Baird and Baird)
Yellow-bellied flycatcher (spring and fall transient)
Empidonax traillii (Audubon) or E. alnorum Brewster
Willow or alder flycatcher (spring and fall transient)
Empidonax minimus (Baird and Baird)
Least flycatcher (summer resident; BB: spring and fall transient, observed once during migration)
Sayornis phoebe (Latham)
Eastern phoebe (summer resident)
Myiarchus crinitus (Linnaeus)
Great crested flycatcher (summer resident, probable breeder)
Tyrannus tyrannus (Linnaeus)
Eastern kingbird (summer resident, confirmed breeder)

Vireonidae
Vireo flavifrons Vieillot
Yellow-throated vireo (spring and fall transient)
Vireo solitarius (Wilson)
Blue-headed (solitary) vireo (spring and fall transient; BB: summer resident, observed throughout the summer in two locations)
Vireo gilvus (Vieillot)
Warbling vireo (spring and fall transient)

Vireo olivaceus (Linnaeus)
Red-eyed vireo (summer resident, probable breeder)

Corvidae
Cyanocitta cristata (Linnaeus)
Blue jay (permanent resident, confirmed breeder; common)
Corvus brachyrhynchos Brehm
American crow (permanent resident, confirmed breeder)

Hirundinidae
Progne subis (Linnaeus)
Purple martin (summer visitor)
Tachycineta bicolor (Vieillot)
Tree swallow (summer resident, confirmed breeder)
Stelgidopterix serripennis (Audubon)
Northern rough-winged swallow (summer resident)
Riparia riparia (Linnaeus)
Bank swallow (summer resident, probable breeder)
Petrochelidon pyrrhonta Vieillot
Cliff swallow (summer visitor)
Hirundo rustica Linnaeus
Barn swallow (summer resident, confirmed breeder)

Paridae
Parus atricapillus Linnaeus
Black-capped chickadee (permanent resident, confirmed breeder)
Parus hudsonicus Forster
Boreal chickadee (winter visitor)
Parus bicolor Linnaeus
Tufted titmouse (permanent resident)

Sittidae
Sitta canadensis Linnaeus
Red-breasted nuthatch (permanent resident)
Sitta carolinensis Latham
White-breasted nuthatch (permanent resident)

Certhiidae
Certhia americana Bonaparte
Brown creeper (permanent resident)

Troglodytidae
Troglodytes aedon Vieillot
House wren (summer resident, confirmed breeder)
Troglodytes troglodytes (Linnaeus)
Winter wren (winter visitor)
Cistothorus palustris (Wilson)
Marsh wren (summer visitor)

Regulidae
Regulus satrapa Lichtenstein
Golden-crowned kinglet (winter visitor)
Regulus calendula (Linnaeus)
Ruby-crowned kinglet (spring and fall transient)

Sylviidae
- Polioptila caerulea (Linnaeus)
  - Blue-gray gnatcatcher (summer resident; BB: not observed)

Turdidae
- Sialia sialis (Linnaeus)
  - Eastern bluebird (summer resident, confirmed breeder)
- Catharus fuscescens (Stephens)
  - Veery (summer visitor, probable breeder; BB: summer resident, observed in many locations throughout the summer)
- Catharus minimus (Lafresnaye)
  - Gray-cheeked thrush (summer visitor)
- Catharus ustulatus (Nuttall)
  - Swainson's thrush (summer visitor)
- Catharus guttatus (Pallas)
  - Hermit thrush (summer resident)
- Hylocichla mustelina (Gmelin)
  - Wood thrush (summer resident, confirmed breeder)
- Turdus migratorius Linnaeus
  - American robin (summer resident, confirmed breeder)

Mimidae
- Dumetella carolinensis (Linnaeus)
  - Gray catbird (summer resident, confirmed breeder)
- Mimus polyglottos (Linnaeus)
  - Northern mockingbird (permanent resident, confirmed breeder)
- Toxostoma rufum (Linnaeus)
  - Brown thrasher (summer resident, confirmed breeder)

Sturnidae
- Strunus vulgaris Linnaeus
  - European starling (permanent resident, confirmed breeder)

Bombycillidae
- Bombycilla cedrorum Vieillot
  - Cedar waxwing (permanent resident)

Parulidae
- Vermivora chrysoptera (Linnaeus)
  - Golden-winged warbler (summer resident; BB: not observed). Also Brewster's warbler (summer visitor), a hybrid form between V. chrysoptera (Linnaeus) and the blue-winged warbler, V. pinus (Linnaeus); doubtful taxonomic status.
- Vermivora pinus (Linnaeus)
  - Blue-winged warbler (spring and fall transient, observed during migration; BB: summer resident, probable breeder)
- Vermivora ruficapilla (Wilson)
  - Nashville warbler (spring and fall transient)
- Parula americana (Linnaeus)
  - Northern parula (spring and fall transient)
- Dendroica petechia (Linnaeus)
  - Yellow warbler (summer resident, probable breeder; BB: not observed)
- Dendroica pensylvanica (Linnaeus)
  - Chestnut-sided warbler (summer resident)
- Dendroica magnolia (Wilson)
  - Magnolia warbler (spring and fall transient)

Dendroica tigrina (Gmelin)
Cape May warbler (spring and fall transient)
Dendroica caeruleseens (Gmelin)
Black-throated blue warbler (spring and fall transient)
Dendroica coronata (Linnaeus)
Yellow-rumped warbler (spring and fall transient)
Dendroica virens (Gmelin)
Black-throated green warbler (spring and fall transient)
Dendroica fusca (Müller)
Blackburnian warbler (spring and fall transient)
Dendroica pinus (Wilson)
Pine warbler (summer resident)
Dendroica discolor (Vieillot)
Prairie warbler (summer resident, eonfirmed breeder; common)
Dendroica palmarum (Gmelin)
Palm warbler (spring and fall transient)
Dendroica castanca (Wilson)
Bay-breasted warbler (spring and fall transient)
Dendroica striata (Forster)
Blackpoll warbler (spring and fall transient)
Mniotilta varia (Linnaeus)
Black-and-white warbler (spring and fall transient; Kerlinger and Doremus [1981a]: breeder)
Setophaga rutieilla (Linnaeus)
American redstart (spring and fall transient)
Seiurus aurocapillus (Linnaeus)
Ovenbird (summer resident, breeding species)
Seiurus noveboracensis (Gmelin)
Northern waterthrush (spring and fall transient)
Seiurus motacilla (Vieillot)
Louisiana waterthrush (summer resident; BB: not observed)
Geothlypis trichas (Linnaeus)
Common yellowthroat (summer resident, confirmed breeder; common)
Wilsonia canadensis (Linnaeus)
Canada warbler (summer resident; BB: spring and fall transient, observed during migration, absent during summer)
Wilsonia citrina (Boddaert)
Hooded warbler (BB: summer resident, probable breeder, observed in multiple locations throughout the summer)
Icteria virens (Linnaeus)
Yellow-breasted chat (summer resident; BB: not observed)

Thraupidae
Piranga olivacea (Gmelin)
Scarlet tanager (summer resident)

Emberizidae
Pipilo erythrophthalmus (Linnaeus)
Eastern (rufous-sided) towhee (summer resident, eonfirmed breeder; eommon)
Spizella arborea (Wilson)
American tree sparrow (winter visitor)
Spizella passerina (Bechstein)
Chipping sparrow (summer resident; BB: probable breeder)
Spizella pusilla (Wilson)
Field sparrow (summer resident, confirmed breeder; common)

Pooecetes gramineus (Gmelin)
Vesper sparrow (summer resident; BB: not observed)
Passerculus sandwichensis (Gmelin)
Savannah sparrow (summer visitor)
Ammodramus savannarum (Gmelin)
Grasshopper sparrow (summer visitor)
Passerella iliaca (Merrem)
Fox sparrow (spring and fall transient)
Melospiza melodia (Wilson)
Song sparrow (summer resident, confirmed breeder)
Melospiza georgiana (Latham)
Swamp sparrow (summer resident; BB: not observed)
Zonotrichia albicollis (Gmelin)
White-throated sparrow (spring and fall transient; Kerlinger and Doremus [1981a]: breeder)
Zonotrichia leucophrys (Forster)
White-crowned sparrow (spring and fall transient)
Junco hyemalis (Linnaeus)
Dark-eyed junco (winter visitor)

Cardinalidae
Cardinalis cardinalis (Linnaeus)
Northern cardinal (permanent resident, confirmed breeder)
Pheucticus ludovicianus (Linnaeus)
Rose-breasted grosbeak (summer resident, probable breeder)
Passerina cyanea (Linnaeus)
Indigo bunting (summer resident, confirmed breeder)

Icteridae
Dolichonyx oryzivorus (Linnaeus)
Bobolink (summer visitor)
Agelaius phoeniceus (Linnaeus)
Red-winged blackbird (summer resident, confirmed breeder)
Sturnella magna (Linnaeus)
Eastern meadowlark (summer resident; BB: not observed)
Euphagus carolinus (Müller)
Rusty blackbird (spring and fall transient)
Quiscalus quiscula (Linnaeus)
Common grackle (summer resident)
Molothrus ater (Boddaert)
Brown-headed cowbird (summer resident, probable breeder; common)
Icterus galbula (Linnaeus)
Baltimore (northern) oriole (summer resident, confirmed breeder)

Fringillidae
Pinicola enucleator (Linnaeus)
Pine grosbeak (winter visitor)
Carpodacus purpureus (Gmelin)
Purple finch (winter visitor)
Carpodacus mexicanus (Müller)
House finch (confirmed breeder)
Loxia curvirostra Linnaeus
Red crossbill (winter visitor)
Loxia leucoptera Gmelin
White-winged crossbill (winter visitor)

Carduelis flammea (Linnaeus)
Common redpoll (winter visitor)
Carduelis pinus (Wilson)
Pine siskin (winter visitor)
Carduelis tristis (Linnaeus)
American goldfinch (permanent resident, probable breeder)
Coccothraustes vespertinus (Cooper)
Evening grosbeak (winter visitor)

Passeridae
Passer domesticus (Linnaeus)
House sparrow (permanent resident, confirmed breeder)

# Appendix G

## Mammals Species List

The list of mammals recorded from the Albany Pine Bush was compiled by combining published lists from Miller (1976) and *The Pine Bush Intermunicipal Study* (Miller 1980). Roland Kays (RK) of the New York State Museum provided new data. Taxa are arranged according to Whitaker and Hamilton (1998). The northern myotis, previously regarded as an eastern form of Keen's bat, is now considered a separate species. The native red fox of the United States was long recognized as a separate species, *Vulpes fulva*, but recently acquired evidence indicates that it is the same as the Old World red fox.

**Class Mammalia: Order Didelphimorphia**
Didelphidae
- Didelphis virginiana Kerr
  - Virginia opossum

**Class Mammalia: Order Insectivora**
Soricidae
- Blarina brevicauda (Say)
  - Northern short-tailed shrew
- Sorex cinereus Kerr
  - Masked shrew

Talpidae
- Condylura cristata (Linnaeus)
  - Star-nosed mole
- Parascalops breweri (Bachman)
  - Hairy-tailed mole

**Class Mammalia: Order Chiroptera**
Vespertilionidae
- Eptesicus fuscus (Palisot de Beauvois)
  - Big brown bat
- Lasiurus borealis (Müller)
  - Eastern red bat
- Myotis lucifugus (Le Conte)
  - Little brown myotis
- Myotis septentrionalis (Trouessart)
  - Northern myotis

**Class Mammalia: Order Lagomorpha**
Leporidae
- Sylvilagus floridanus (Allen)
  - Eastern cottontail

**Class Mammalia: Order Rodentia**

Sciuridae
- Glaucomys volans (Linnaeus)
  - Southern flying squirrel
- Marmota monax (Linnaeus)
  - Woodchuck, groundhog
- Sciurus carolinensis Gmelin
  - Eastern gray squirrel
- Tamias striatus (Linnaeus)
  - Eastern chipmunk
- Tamiasciurus hudsonicus (Erxleben)
  - Red squirrel, chickaree

Dipodidae (Zapodinae)
- Napaeozapus insignis (Miller)
  - Woodland jumping mouse
- Zapus hudsonius (Zimmermann)
  - Meadow jumping mouse (extremely rare)

Muridae (Arvicolinae)
- Clethrionomys gapperi (Vigors)
  - Southern red-backed vole
- Microtus pennsylvanicus (Ord)
  - Meadow vole
- Microtus pinetorum (Le Conte)
  - Woodland vole (RK: new record)
- Ondatra zibethicus (Linnaeus)
  - Common muskrat

Muridae (Murinae)
- Mus musculus Linnaeus
  - House mouse
- Rattus norvegicus (Berkenhout)
  - Norway rat, brown rat

Muridae (Sigmodontinae)
- Peromyscus leucopus (Rafinesque)
  - White-footed mouse
- Peromyscus maniculatus (Wagner)
  - Woodland deer mouse

Erethizontidae
- Erethizon dorsatum (Linnaeus)
  - North American porcupine (RK: new record)

**Class Mammalia: Order Carnivora**

Canidae
- Canis latrans Say
  - Coyote
- Urocyon cinereoargenteus (Schreber)
  - Gray fox
- Vulpes vulpes (Linnaeus)
  - Red fox

Ursidae
Ursus americanus Pallas
Black bear (rare visitor)

Procyonidae
Procyon lotor (Linnaeus)
Common raccoon

Mustelidae
Martes pennanti (Erxleben)
Fisher (RK: new record)
Mustela erminea Linnaeus
Ermine (short-tailed weasel)
Mustela frenata Lichtenstein
Long-tailed weasel
Mustela vison Schreber
Mink (extremely rare)

Mephitidae
Mephitis mephitis (Schreber)
Striped skunk

Felidae
Felis catus Linnaeus
Domestic cat
Lynx rufus (Schreber)
Bobcat (rare visitor; RK: new record)

**Class Mammalia: Order Artiodactyla**
Cervidae
Odocoileus virginianus (Zimmermann)
White-tailed deer

# References Cited


*Albany Argus.* 1814. Advertisement for Hamilton Glass Factory. 15 February. 2 (111): 4.

Albany Pine Bush Preserve Commission Technical Committee. 1996. The Albany Pine Bush Preserve: protection and project review implementation guidelines and final environmental impact statement. A supplement and amendment to the 1993 management plan and final environmental impact statement. Albany Pine Bush Preserve Commission, Albany, New York. 36 pages.

Allen, M. F. 1991. The ecology of mycorrhizae. Cambridge University Press, New York. 184 pages.

Andow, D. A., R. J. Baker, and C. P. Lane (eds.). 1994. Karner blue butterfly: a symbol of a vanishing landscape. University of Minnesota Agricultural Experiment Station Technical Publication 84-1994. 222 pages.

Andrle, R. F. and J. R. Carroll. 1988. The atlas of breeding birds in New York State. Cornell University Press, Ithaca, New York. 551 pages.

Andrus, R. E., W. R. Town, and E. F. Karlin. 1994. New York State *Sphagnum* revisions. Bulletin of the Torrey Botanical Club 121: 69–72.

Anonymous. 1843. The New-York State guide. J. Disturnell, Albany, New York. 96 pages.

Austin, G. T. 1998. Spatial patterns of aspen (*Populus tremuloides* and *P. grandidentata*) invasion in the Albany Pine Bush. New York Natural History Conference Abstracts (New York State Museum) 5: 1–2.

Bailey, J. S. 1877. Center, N.Y., entomologically considered. Canadian Entomologist 9: 115–119.

Baker, R. J. 1994. The Karner blue butterfly: 1993 and beyond. Pages 163–169 in D. A. Andow, R. J. Baker, and C. P. Lane (eds.), Karner blue butterfly: a symbol of a vanishing landscape. University of Minnesota Agricultural Experiment Station Technical Publication 84-1994. 222 pages.

Bassette, A. E., A. R. Bassette, and D. W. Fischer. 1997. Mushrooms of northeastern North America. Syracuse University Press, Syracuse, New York. 582 pages.

Beachy, B. L. 2002. Invading trees and breeding birds in the Albany Pine Bush. Master's thesis, State University of New York at Albany.

Beachy, B. L. and G. R. Robinson. 2002. Invading trees and breeding birds in the Albany Pine Bush. Northeast Natural History Conference Abstracts 7 (New York State Museum Circular 64): 76–77.

Bernard, J. M. and F. K. Seischab. 1995. Pitch pine (*Pinus rigida* Mill.) communities in northeastern New York State. American Midland Naturalist 134: 294–306.

Bogan, D. A. and R. Kays. 2002. Home range and diet of eastern coyotes from a suburban forest preserve. Northeast Natural History Conference Abstracts 7 (New York State Museum Circular 64): 77.

Bogart, J. P. and M. W. Klemens. 1997. Hybrids and genetic interactions of mole salamanders (*Ambystoma jeffersonianum* and *A. laterale*) (Amphibia: Caudata) in New York and New England. American Museum Novitates 3218: 1–78.

Bond, W. J. and B. W. van Wilgen. 1996. Fire and plants. Chapman and Hall, New York. 263 pages.

Bormann, F. H. and G. E. Likens. 1979. Catastrophic disturbance and the steady state in northern hardwood forests. American Scientist 67: 660–669.

Boyd, H. P. 1973. Collecting tiger beetles in the Pine Barrens of New Jersey. Cicindela 5 (1): 1–12.

Boyle, R. H. 1969. The Hudson River, a natural and unnatural history. W. W. Norton, New York. 304 pages.

Brinkman, W. A. 1945. Historical data of the Town of Guilderland, New York. Town of Guilderland Historian, New York.

Bristol, Litynski, Wojcik, P.C. 1980. The Pine Bush intermunicipal study. Technical report. Saratoga Springs, New York. 263 pages.

Brown, J. H. 1992. Soil survey of Albany County, New York. U.S. Department of Agriculture Soil Conservation Service. 285 pages.

Brown, L. 1979. Grasses: an identification guide. Houghton Mifflin, Boston. 240 pages.

Brunner, A. W. and C. D. Lay. 1914. Studies for Albany. 101 pages.

Buchholz, K. and H. Motto. 1981. Abundances and vertical distributions of mycorrhizae in plains and barrens forest soils from the New Jersey Pine Barrens. Bulletin of the Torrey Botanical Club 108 (2): 268–271.

Budiansky, S. 1998. Some historical influences on modern views of nature in America. Transactions of the Wisconsin Academy of Sciences, Arts, and Letters 86: 19–33.

Buffington, J. D. 1967. Soil arthropod populations of the New Jersey Pine Barrens as affected by fire. Annals of the Entomological Society of America 69: 530–535.

Bull, J. 1974. Birds of New York State. American Museum of Natural History, New York. 655 pages.

Burns, R. M. and B. H. Honkala. 1990. Silvics of North America. 2 volumes. Agriculture Handbook (U.S. Department of Agriculture, Forest Service) 654. 877 pages. Available: http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm

Buttner, P. J. R. 1976. Water—the key element of the Pine Bush ecosystem. Pages 23–32 in D. Rittner (ed.), Pine Bush: Albany's last frontier. Pine Bush Historic Preservation Project, Albany, New York. 266 pages.

Cane, J. 1973. [Letter]. News of the Lepidopterists' Society (15 January): 4.

Catling, P. M., S. M. McKay-Kuja, and G. Mitrow. 1999. Rank and typification in North American dwarf cherries, and a key to the taxa. Taxon 48: 483–488.

Clark, G. T. 1971. The ecological life history of *Tephrosia virginiana* (L.) Pers. Doctoral dissertation, University of Arkansas (Fayetteville). 87 pages.

Collins, J. T. 1997. Standard common and current scientific names for North American amphibians and reptiles, 4th ed. Society for the Study of Amphibians and Reptiles. 40 pages.

Cook, J. H. 1930. The glacial geology of the Capital District. New York State Museum Bulletin 185: 181–213.

Corning, E. 1976. Foreword. Page iii in D. Rittner (ed.), Pine Bush: Albany's last frontier. Pine Bush Historic Preservation Project, Albany, New York. 266 pages.

Crum, H. 1983. Mosses of the Great Lakes forest, 3rd ed. University Herbarium, University of Michigan, Ann Arbor. 417 pages.

Crum, H. A. and L. E. Anderson. 1981. Mosses of eastern North America. Columbia University Press, New York. 1328 pages.

Dawson, A. G. 1992. Ice age Earth: Late Quaternary geology and climate. Routledge, Chapman and Hall, New York. 293 pages.

Day, G. M. 1953. The Indian as an ecological factor in the northeastern forest. Ecology 34 (2): 329–346.

Dean, J. K. 1976. Species of fungi described as new to science from the sand plains area of Albany, New York: and for which type specimens are present in the herbarium of the New York State Museum. Pages 94–101 in D. Rittner (ed.), Pine Bush: Albany's last frontier. Pine Bush Historic Preservation Project, Albany, New York. 266 pages.

Delcourt, P. A. and H. R. Delcourt. 1981. Vegetation maps for eastern North America: 40,000 yr. B.P. to the present. Pages 123–165 in R. C. Romans (ed.), Geobotany II. Plenum Press, New York. 263 pages.

Dindal, D. L. 1998. Soil arthropod microcommunities of the Pine Barrens. Pages 527–539 in R. T. T. Forman (ed.), Pine Barrens: ecosystem and landscape, revised edition. Rutgers University Press, New Brunswick, New Jersey. 601 pages.

Dineen, R. (ed.). 1975. Geology and land uses in the Pine Bush, Albany County, New York. New York State Museum and Science Service Circular 47: 1–27.

Dineen, R. 1976. Surficial geology of the Pine Bush ecosystem. Pages 1–15 in D. Rittner (ed.), Pine Bush: Albany's last frontier. Pine Bush Historic Preservation Project, Albany, New York. 266 pages.

Dineen, R. 1979. Groundwater hydrology of the Albany Pine Bush with suggestions for land-use planning. Skenaectada (American Pine Barrens Society, Inc.) 1: 39–45.

Dineen, R. 1982. The geology of the Pine Bush aquifer, north-central Albany County, New York. New York State Museum Bulletin 449: 1–26.

Dirig, R. 1973. The endangered Karner blue. New York State Conservationist 28 (2): 6, 47.

Dirig, R. 1986a. Periodic observations of fruiting fungi and *Sphagnum* at the Pine Bush, Albany County, New York, 1973–1984. Skenectada (American Pine Barrens Society, Inc.) 3: 24–25.

Dirig, R. 1986b. Preliminary annotated list of bryophytes of the Pine Bush, Albany County, New York, and vicinity. Evansia 3: 39–43.

Dirig, R. 1994. Historical notes on wild lupine and the Karner blue butterfly at the Albany Pine Bush, New York. Pages 23–36 in D. A. Andow, R. J. Baker, and C. P. Lane (eds.), Karner blue butterfly: a symbol of a vanishing landscape. University of Minnesota Agricultural Experiment Station Technical Publication 84-1994. 222 pages.

Dirig, R. 1996. Theme in blue: Vladimir Nabokov's endangered butterfly. New York Natural History Conference Abstracts (New York State Museum) 4: 40.

Dirig, R. 2003. Theme in blue: Vladimir Nabakov's endangered butterfly. Pages 205–218 in G. Shapiro (ed.), Nabakov at Cornell. Cornell University Press, Ithaca, New York. 288 pages.

Dirig, R. and J. F. Cryan. 1975. Endangered Pine Bush Lepidoptera: the fragile ecology of the Karner blue and buck moth, revised edition. Robert Dirig (published privately), Ithaca, New York. 12 pages.

Donahue, J. 1976. Origins and topography of the Pine Bush. Pages 17–22 in D. Rittner (ed.), Pine Bush: Albany's last frontier. Pine Bush Historic Preservation Project, Albany, New York. 266 pages.

Dudley, J. L. and K. Lajtha. 1993. The effects of prescribed burning on nutrient availability and primary production in sandplain grasslands. American Midland Naturalist 130: 286–298.

Duke, J. A. 1985. CRC handbook of medicinal herbs. CRC Press, Boca Raton, Florida.

Duke, J. A. 1986. Handbook of northeastern Indian medicinal plants. Quarterman Publications, Lincoln, Massachusetts.

Dwight, T. 1969. Travels in New England and New York (B. M. Solomon, ed.). Belknap Press of Harvard University Press, Cambridge, Massachusetts. [Originally published 1821].

Eaton, E. H. 1910–1914. Birds of New York. New York State Museum Memoir 12. Part 1: 501 pages. Part 2: 719 pages.

Eights, J. 1835. The naturalist's every day book. Zodiac 1: 23–28, 33–35, 62.

Eights, J. 1836. The naturalist's every day book. Zodiac 1: 129–132.

Environmental Design and Research, P.C. 1993. Management plan and final environmental impact statement for the Albany Pine Bush Preserve. The Albany Pine Bush Preserve Commission. 152 pages.

Erickson, J. 1990. Ice ages past and future. Tab Books, Blue Ridge Summit, Pennsylvania. 177 pages.

Ernst, C. H., R. W. Barbour, and J. E. Lovich. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 578 pages.

Fang, W., J. Kaplan, M. Jordan, and J. Gurevitch. 1998. Field experiments on factors limiting pitch pine seedlings after fire. New York Natural History Conference Abstracts (New York State Museum) 5: 47.

Federation of New York State Bird Clubs, Inc. 1999. Checklist of the birds of New York State. FNYSBC, Inc., Durhamville, New York. Available: http://www.fnysbc.org

Felt, E. P. 1940. Plant galls and gall makers. Comstock Publishing Company, Ithaca, New York (reprinted in 1965 by the Hafner Publishing Company, New York). 364 pages.

Finnegan, R. J. 1965. The pine needle miner, *Exoteleia pinifoliella* (Chamb.) (Lepidoptera: Gelechiidae), in Quebec. Canadian Entomologist 97: 744–750.

Finton, A. 1998. Succession and plant community development in pitch pine–scrub oak barrens of the glaciated northeast United States. Master's thesis, University of Massachusetts Amherst.

Forman, R. T. T. 1998. Common bryophytes and lichens of the New Jersey Pine Barrens. Pages 407–424 in R. T. T. Forman (ed.), Pine Barrens: ecosystem and landscape (revised edition). Rutgers University Press, New Brunswick, New Jersey. 601 pages.

Frankel, E. 1981. Ferns: a natural history. The Stephen Greene Press, Brattleboro, Vermont.

Gebauer, S. B. 1996. Determination of the number of acres of fire manageable pitch pine-scrub oak barrens in the Albany Pine Bush Preserve. Albany Pine Bush Preserve Technical Committee, Albany, New York. 8 pages.

Gifford, N. A. 1998. Impacts of invasive plants on the ecology and management of the Albany Pine Bush Preserve. New York Natural History Conference Abstracts (New York State Museum) 5: 12–13.

Gill, R. J. 1997. The influences of habitat fragmentation on edge effects in the Albany Pine Bush Preserve. Master's thesis, State University of New York at Albany.

Gill, R. J. 1998. Black locust invasion in the Albany Pine Bush and its effect on a native species. New York Natural History Conference Abstracts (New York State Museum) 5: 13.

Gill, R. J. and G. R. Robinson. 1996. Habitat fragmentation and edge effects in the Albany Pine Bush. New York Natural History Conference IV (New York State Museum): 28–29.

Ginsburg, A. 1998. Making the world more beautiful. Wild Garden 1 (3): 52–55.

Givnish, T. J., E. S. Menges, and D. F. Schweitzer. 1988. Minimum area requirements for long-term conservation of the Albany Pine Bush and Karner blue butterfly: an assessment. Malcolm Pirnie, Albany, New York.

Gregg, A. B. 1936. Old Hellebergh: historical sketches of the West Manor of Rensselaerswyck, including an account of the anti-rent wars, the glass house and Henry R. Schoolcraft. The Altamont Enterprise, Altamont, New York.

Gregg, A. B. 1951. Outline history of the Town of Guilderland, Albany County, New York. Guilderland Town Board. 7 pages.

Haines, J. H., L. J. Craig, and P. F. Steblein. 1990. Selective mycophagy by the red-backed vole and the southern flying squirrel. New York Natural History Conference Abstracts (New York State Museum) 1: 32.

Hamilton, C. C. 1925. Studies on the morphology, taxonomy, and ecology of the larvae of holarctic tiger-beetles (Family Cicindelidae). Proceedings of the United States National Museum 65 (No. 2530, Article 17): 1–87.

Harper, M. G., C. H. Dietrich, R. L. Larimore, and P. A. Tessene. 2000. Effects of prescribed fire on prairie arthropods: an enclosure study. Natural Areas Journal 20 (4): 325–335.

Hill, W. H. 1882. Rare noctuids. Papilio 2 (3): 50.

Hitchcock, A. S. 1950. Manual of the grasses of the United States. U.S. Department of Agriculture Miscellaneous Publication 200: 1–1051.

Hodges, R. W., T. Dominick, D. R. Davis, D. C. Ferguson, J. G. Franclemont, E. G. Munroe, and J. A. Powell (eds.). 1983. Check list of the Lepidoptera of America North of Mexico. E. W. Classey Limited and The Wedge Entomological Research Foundation, London. 284 pages.

Howell, G. R. and J. Tenney (eds.). 1886. History of the County of Albany, N.Y., from 1609 to 1886. W. W. Munsell & Co., Publishers, New York. 997 pages.

Huey, P. R. 1975. History of the Pine Bush from 1624 to 1815, Albany County, New York. Pages 7–8 in R. Dineen (ed.), Geology and land uses in the Pine Bush, Albany County, New York. New York State Museum and Science Service Circular 47: 1–27.

Hunsinger, K. C. 1998. A radio telemetry study of an eastern hognose snake (*Heterodon p. platirhinos*). New York Natural History Conference Abstracts 5: 50.

Hunsinger, K. C. 1999. A survey of the amphibians and reptiles of the Abany Pine Bush, Albany County, New York. Master's thesis, The University at Albany, Albany, New York. 73 pages.

Hunt, D. M. 1995. NYFA base list, flora of Albany Pine Bush. New York Natural Heritage Program, Latham, New York.

Jiusto, J., K. Petersen, R. Peterson, N. Pierson, and N. Rosenbach. 1971. Operation Pinebush: report of the Research Subcommittee, Preservation of the Albany Pinebush: need, feasibility, and recommendations. Eastern New York Chapter of The Nature Conservancy, and the Town of Guilderland. 8 pages.

Johnson, A. H., T. G. Siccama, D. Wang, R. S. Turner, and T. H Barringer. 1981. Recent changes in patterns of tree growth rate in the New Jersey Pinelands: a possible effect of acid rain. Journal of Environmental Quality 10 (4): 427–430.

Johnson, W. C., C. S. Adkisson, T. R. Crow, and M. D. Dixon. 1997. Nut caching by blue jays (*Cyanocitta cristata* L.): implications for tree demography. American Midland Naturalist 138: 357–370.

Johnson, W. C. and T. Webb III. 1989. The role of blue jays (*Cyanocitta cristata* L.) in the postglacial dispersal of fagaceous trees in eastern North America. Journal of Biogeography 16: 561–571.

Jones, R. L. 1983. A systematic study of *Aster* section *Patentes* (Asteraceae). SIDA 10 (1): 41–81.

Jones, R. L. 1992. Additional studies of *Aster georgianus*, *A. patens*, and *A. phlogifolius* (Asteraceae). SIDA 15 (2): 305–315.

Kalisz, P. J. and J. E. Powell. 2000. Effects of prescribed fire on soil invertebrates in upland forests on the Cumberland Plateau of Kentucky, USA. Natural Areas Journal 20 (4): 336–341.

Kerlinger, P. and C. Doremus. 1981a. The breeding birds of three pine barrens in New York State. Kingbird 31 (3): 126–135.

Kerlinger, P. and C. Doremus. 1981b. Habitat disturbance and the decline of dominant avian species in pine barrens of the northeastern United States. American Birds 35: 16–20.

Knisley, C. B. and T. D. Schultz. 1997. The biology of tiger beetles and a guide to the species of the South Atlantic States. Virginia Museum of Natural History Special Publication No. 5: 1–210.

Kucera, C. L. 1998. The grasses of Missouri. University of Missouri Press, Columbia. 305 pages.

Kurczewski, F. E. 1998. Distribution, status, evaluation, and recommendations for the protection of *Tachysphex pechumani* Krombein, the antennal-waving wasp. Natural Areas Journal 18: 242–254.

Kurczewski, F. E. 1999. Historic and prehistoric changes in the Rome, New York pine barrens. Northeastern Naturalist 6 (4): 327–340.

Kurczewski, F. E. and H. F. Boyle. 2000. Historical changes in the pine barrens of central Suffolk County, New York. Northeastern Naturalist 7 (2): 95–112.

LaFleur, R. G. 1968. Glacial Lake Albany. Pages 455–456 in R. W. Fairbridge (ed.), The encyclopedia of geomorphology. Reinhold Book Corporation, New York. 1295 pages.

LaFleur, R. G. 1976. Glacial Lake Albany. Pages 1–10 in D. Rittner (ed.), Pine Bush: Albany's last frontier. Pine Bush Historic Preservation Project, Albany, New York. 266 pages.

Landry, R. J. and G. L. Rosenberg. 1976. Pine Bush soil interpretation report. Pages 35–46 in D. Rittner (ed.), Pine Bush: Albany's last frontier. Pine Bush Historic Preservation Project, Albany, New York. 266 pages.

Ledig, F. T. and S. Little. 1998. Pitch pine (*Pinus rigida* Mill.): ecology, physiology, and genetics. Pages 347–371 in R. T. T. Forman (ed.), Pine Barrens: ecosystem and landscape (revised edition). Rutgers University Press, New Brunswick, New Jersey. 601 pages.

Leithead, H. L., L. L. Yarlett, and T. N. Shiflet. 1971. 100 native forage grasses in 11 southern states. U.S. Department of Agriculture Soil Conservation Service Agriculture Handbook 389: 1–216.

Lewis, D. M. 1976. The past vegetation of the Pine Bush. Pages 81–90 in D. Rittner (ed.), Pine Bush: Albany's last frontier. Pine Bush Historic Preservation Project, Albany, New York. 266 pages.

Lintner, J. A. 1889. Report of the State Entomologist for the year 1888. Annual Report of the (New York) State Museum 42: 145–347.

Lintner, J. A. 1890. Contributions to the department. Sixth report on the injurious and other insects of the State of New York. New York State Museum Annual Report 43 (1889): 186–187.

Lintner, J. A. 1894. Contributions to the department in 1893. Report of the State Entomologist. New York State Museum Annual Report 48: 509.

Marshall, N. L. 1910. Mosses and lichens. Doubleday, Page & Company, New York. 327 pages.

Martin, K. L. 1977. Spatial distribution of the scrub oaks, *Quercus ilicifolia* and *Quercus prinoides* in the Pine Bush of eastern New York. Master's thesis, State University of New York at Albany. 42 pages.

Mattox, J. 1994. Wetland vascular flora of the Pine Bush, Albany and Schenectady Counties, New York State, in the 19th and 20th centuries. Master's thesis, Bard College, Annandale-on-Hudson, New York. 197 pages.

McCabe, T. L. 1980 (1982). A preliminary annotated list of Pine Bush caddis. Skenectada (American Pine Barrens Society, Inc.) 2: 17–18.

McCabe, T. L. 1986. An annotated list of Pine Bush caddis. Skenectada (American Pine Barrens Society, Inc.) 3: 17–18.

McCabe, T. L. 1993. Albany Pine Bush Project, 1991–1992 entomological report (unpublished report). New York State Museum. 102 pages.

McCabe, T. L. 1995. The changing insect fauna of Albany's pine barrens. Pages 166–168 in E. T. LaRoe, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac (eds.), Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U.S. Department of the Interior, National Biological Service, Washington, D.C. 530 pages.

McCabe, T. L. and J. P. Huether. 1986. An annotated list of Pine Bush Cerambycidae (Insecta: Coleoptera). Skenectada (American Pine Barrens Society, Inc.) 3: 19–23.

McCabe, T. L. and C. N. Weber. 1994. The robber flies (Diptera: Asilidae) of the Albany Pinebush. Great Lakes Entomologist 27 (3): 157–159.

McClenahen, H. R. and N. H. McCarthy. 1990. An assessment of pitch pine (*Pinus rigida*) health and mortality in southern Ohio. Canadian Journal of Forest Research 20: 1900–1908.

McCullough, D. G., R. A. Werner, and D. Neumann. 1998. Fire and insects in northern and boreal forest ecosystems of North America. Annual Review of Entomology 43: 107–127.

McEneny, J. J. 1981. Albany: capital city on the Hudson. Albany Institute of History and Art, Albany, New York. 248 pages.

McKearin, G. S. and H. McKearin. 1948. American glass. Crown Publishers, New York.

Metz, L. J. and D. L. Dindal. 1975. Collembola populations and prescribed burning. Environmental Entomology 4 (4): 583–587.

Miles, D. W. R. and F. J. Swanson. 1986. Vegetation composition on recent landslides in the Cascade Mountains of Western Oregon. Canadian Journal of Forest Research 16 (4): 739–744.

Miller, H. and S. Lamb. 1985. Oaks of North America. Naturegraph Publishers, Happy Camp, California. 327 pages.

Miller, N. G. and R. S. Mitchell. 1995. Tracking the mosses and vascular plants of New York (1836–1994). Pages 209–210 in E. T. LaRoe, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac (eds.), Our living resources, a report to the nation on the distribution, abundance, health of U.S. plants, animals and ecosystems. U.S. Department of the Interior, National Biological Service. 530 pages.

Miller, O. K. 1977. Mushrooms of North America. E. P. Dutton, New York. 368 pages.

Miller, R. L. 1976. Mammals and birds of Albany's Pine Bush. Pages 171–188 *in* D. Rittner (ed.), Pine Bush: Albany's last frontier. Pine Bush Historic Preservation Project, Albany, New York. 266 pages.

Miller, R. L. 1980. Mammalia. Pages 182–183 *in* The Pine Bush intermunicipal study. Technical report. Bristol, Litynski, Wojcik, P.C., Saratoga Springs, New York. 263 pages.

Milne, B. T. 1979. A preliminary list of lichens of the Albany Pine Bush. Skenectada (Pine Bush Historic Preservation Project, Inc.) 1: 36–38.

Milne, B. T. 1985. Upland vegetational gradients and post-fire succession in the Albany Pine Bush, New York. Bulletin of the Torrey Botanical Club 112 (1): 21–34.

Mitchell, R. S. and G. C. Tucker. 1997. Revised checklist of New York State plants. New York State Museum Bulletin 490: 400 pages.

Morse, J. 1797. The American gazetteer . . . of the . . . American continent, also of the West-India Islands. Boston.

Motzkin, G., D. Foster, A. Allen, J. Harrod, and R. Boone. 1996. Controlling site to evaluate history: vegetation patterns of a New England sand plain. Ecological Monographs 66 (3): 345–365.

Munsell, J. 1870. Collections on the history of Albany, from its discovery to the present time. With notices of its public institutions, and biographical sketches of citizens deceased. Volume 3. J. Munsell, Albany, New York.

Nabokov, D. and M. J. Bruccoli (eds.). 1989. Vladimir Nabokov: selected letters, 1940–1977. Harcourt Brace Jovanovich, San Diego, California. 582 pages.

Nabokov, V. 1943. The nearctic forms of *Lycaeides* Hüb. (Lycaenidae, Lepidoptera). Psyche 50 (3–4): 87–99.

Nabokov, V. 1957. Pnin. Doubleday & Co., Garden City, New York. 191 pages.

Nevin, C. M. 1925. Albany molding sands of the Hudson Valley. New York State Museum Bulletin 263: 1–81.

Newland, D. H. 1916. Albany molding sand. New York State Museum Bulletin 187: 107–115.

Nuzzo, V. A. 1986. Extent and status of Midwest oak savanna: presettlement and 1985. Natural Areas Journal 6 (2): 6–36.

O'Callaghan, E. B. 1850. The documentary history of the State of New York, 4 volumes. Weed, Parsons and Company, Albany.

Opler, P. A. 1974. Oaks as evolutionary islands for leaf-mining insects. American Scientist 62: 67–73.

Opler, P. A. and V. Malikul. 1992. A field guide to eastern butterflies. The Peterson Field Guide Series. Houghton Mifflin, Boston. 396 pages.

Paige, E. W. 1864. Catalogue of the flowering plants of Schenectady County. Albany. 48 pages.

Patterson, W. A. III and A. E. Backman. 1988. Fire and disease history of forests. Pages 603–632 in B. Huntley and T. Webb III (eds.), Vegetation history. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Pownall, T. 1949. Topographical description of the dominions of the United States of America (L. Mulkearn, ed.). University of Pittsburgh Press. 235 pages.

Preston, G. L. 1992. Post-wildfire vegetative regeneration of the scrub oak (*Quercus ilicifolia*) in the Albany Pine Bush. New York Natural History Conference Abstracts (New York State Museum) 2: 59.

Pryor, G. S. and S. E. Bonanno. 1996. Life history of the bog buckmoth in New York. New York Natural History Conference Abstracts (New York State Museum) 4: 39.

Pyne, S. J. 1982. Fire in America: a cultural history of wildland and rural fire. Princeton University Press, Princeton, New Jersey. 654 pages.

Reilly, E. M. 1975. Biota. Pages 9–10 in R. Dineen (ed.), Geology and land uses in the Pine Bush, Albany County, New York. New York State Museum and Science Service Circular 47: 1–27.

Reschke, C. 1990. Ecological communities in New York State. New York Natural Heritage Program, New York State Department of Environmental Conservation, Latham, New York. 96 pages.

Rice, S. K. and J. Wells. 2002. Evaluating strategies to restore nitrogen limitation following black locust invasion. Northeast Natural History Conference Abstracts 7 (New York State Museum Circular 64): 76.

Richardson, D. H. S. 1981. The biology of mosses. John Wiley & Sons, New York. 220 pages.

Ritchie, W. A. 1976. Prehistoric man in the Pine bush. Pages 211–215 in D. Rittner (ed.), Pine Bush: Albany's last frontier. Pine Bush Historic Preservation Project, Albany, New York. 266 pages.

Ritter, A. M. 1941. A biological survey of a sandy area west of Albany. Master's thesis, Cornell University, Ithaca, New York.

Rittner, D. 1976a. Flora of the Pine Bush. Pages 103–116 in D. Rittner (ed.), Pine Bush: Albany's last frontier. Pine Bush Historic Preservation Project, Albany, New York. 266 pages.

Rittner, D. 1976b. Introduction. Pages xvii–xx in D. Rittner (ed.), Pine Bush: Albany's last frontier. Pine Bush Historic Preservation Project, Albany, New York. 266 pages.

Rittner, D. 1976c. Man's activities in the Pine Bush. Pages 217–226 in D. Rittner (ed.), Pine Bush: Albany's last frontier. Pine Bush Historic Preservation Project, Albany, New York. 266 pages.

Rittner, D. 1977. The King's Highway, Albany's first road. NAHO (New York State Museum) 9 (4): 3–7.

Rittner, D. 1979a. An early history of mycology in the Pine Bush. Skenectada (Pine Bush Historic Preservation Project, Inc.) 1: 46–65.

Rittner, D. 1979b. An early history of Pine Bush entomology. Skenectada (Pine Bush Historic Preservation Project, Inc.) 1: 3–35.

Rittner, D. 1979c. Karner blue butterfly nominated as threatened species. Skenectada (Pine Bush Historic Preservation Project, Inc.) 1: 66–67.

Rothaupt, D. J. and W. P. Chamberlain. 1980. Birds. Pages 183–189 in The Pine Bush Intermunicipal Study. Technical Report. Bristol, Litynski, Wojcik, P.C., Saratoga Springs, New York. 263 pages.

Savignano, D. A. 1990. Field investigation of the facultative mutualism between *Lycaeides melissa samuelis* Nabokov (Lycaenidae), the Karner blue butterfly, and attendant ants. Doctoral dissertation, University of Texas, Austin. 119 pages.

Savignano, D. A. 1994. Benefits to Karner blue butterfly larvae from association with ants. Pages 37–46 in D. A. Andow, R. J. Baker, and C. P. Lane (eds.), Karner blue butterfly: a symbol of a vanishing landscape. University of Minnesota Agricultural Experiment Station Technical Publication 84-1994. 222 pages.

Schier, G. A. 1987. Germination and early growth of four pine species on soil treated with simulated acid rain. Canadian Journal of Forest Research 17: 1190–1196.

Schneider, K. J., C. Reschke, and S. M. Young. 1991. Inventory of the rare plants, animals, and ecological communities of the Albany Pine Bush Preserve. Report to the Albany Pine Bush Commission. New York Natural Heritage Program, Latham, New York. 67 pages.

Schroeder, A. B. 1980 (1982). Bluebirds in the Pine Bush. Skenectada (American Pine Barrens Society, Inc.) 2: 30.

Schroeder, A. B. 1986. Pine Bush bluebird update. Skenectada (American Pine Barrens Society, Inc.) 3: 25.

Schweitzer, D. F. 1992. The buckmoths (Lepidoptera, Saturniidae, *Hemileuca*) of New York. New York Natural History Conference Abstracts (New York State Museum) 2: 63–64.

Schweitzer, D. F. and T. J. Rawinski. 1988. Northeastern pitch pine/scrub oak barrens. The Nature Conservancy (Eastern Heritage Task Force), Boston, Massachusetts.

Scoble, M. J. (ed.). 1999. Geometrid moths of the world: a catalogue (Lepidoptera, Geometridae). CSIRO Publishing, Collingwood, Victoria, Australia. 1016 pages.

Scudder, S. H. 1889. The butterflies of the eastern United States and Canada, with special reference to New England. Volume 3. Cambridge, Massachusetts.

Seischab, F. K. and J. M. Bernard. 1991. Pitch pine (*Pinus rigida* Mill.) communities in central and western New York. Bulletin of the Torrey Botanical Club 118 (4): 412–423.

Seischab, F. K. and J. M. Bernard. 1996. Pitch pine (*Pinus rigida* Mill.) communities in the Hudson Valley Region of New York. American Midland Naturalist 136: 42–56.

Seischab, F. K. and D. Orwig. 1991. Catastrophic disturbances in the presettlement forests of western New York. Bulletin of the Torrey Botanical Club 118 (2): 117–122.

Seviers, A. F., G. A. Russell, M. S. Lowman, E. D. Fowler, C. O. Erlanson, and V. A. Little. 1938. Studies on the possibilities of devil's shoestring (*Tephrosia virginiana*) and other native species of *Tephrosia* as commercial sources of insecticides. U.S. Department of Agriculture Technical Bulletin 595. 40 pages.

Seymour, R. S., A. S. White, and P. G. deMaynadier. 2002. Natural disturbance regimes in northeastern North America – evaluating silvicultural systems using natural scales and frequencies. Forest Ecology and Management 155 (1-3): 357-367.

Sheley, R. L., J. S. Jacobs, and M. F. Carpinelli. 1998. Distribution, biology, and management of diffuse knapweed (*Centraurea diffusa*) and spotted knapweed (*Centaurea maculosa*). Weed Technology 12: 353–362.

Smith, C. L. 1985. The inland fishes of New York State. New York State Department of Environmental Conservation. 522 pages.

Smith, S. E. 1976. Pine Bush climate and air quality. Pages 73–80 in D. Rittner (ed.), Pine Bush: Albany's last frontier. Pine Bush Historic Preservation Project, Albany, New York. 266 pages.

Stewart, M. M. 1976. Amphibians and reptiles of the Albany Pine Bush. Pages 189–196 in D. Rittner (ed.), Pine Bush, Albany's last frontier. Pine Bush Historic Preservation Project, Albany, New York. 266 pages.

Stewart, M. M. and J. Rossi. 1981. The Albany Pine Bush: a northern outpost for southern species of amphibians and reptiles in New York. American Midland Naturalist 106 (2): 282–292.

Stewart, M. M. and C. Ricci. 1988. Dearth of the blues. Natural History 97 (5): 64–71.

Stewart, M. M., A. H. Worthington, and G. Preston. 1992. Regeneration of scrub oak following fire and mechanical removal in the Albany Pine Bush. New York Natural History Conference Abstracts (New York State Museum) 2: 70.

Stewart, O. C. 1956. Fire as the first great force employed by man. Pages 115–133 in W. L. Thomas, Jr. (ed.), Man's role in changing the face of the earth. University of Chicago Press, Chicago.

Swan, F. R. 1970. Post-fire response of four plant communities in south-central New York State. Ecology 51 (6): 1074–1082

Swengel, A. B. 1995. Observations of spring larvae of *Lycaeides melissa samuelis* (Lepidoptera: Lycaenidae) in central Wisconsin. Great Lakes Entomologist 28 (2): 155–170.

Swengel, A. B. 1996. Effects of fire and hay management on abundance of prairie butterflies. Biological Conservation 76: 73–85.

Taylor, A. R. 1969. Lightning effects on the forest complex. Proceedings Annual Tall Timbers Fire Ecology Conference 9: 127–150.

Thaler, J. S. 1992. Climate of Albany County: data summary and aspects of temperature, precipitation and snowfall. Revised September 1992. Hudson Valley Climate Service. Mahopac, New York. 26 pages.

Tierney, D. and M. M. Stewart. 2001. *Scaphiopus holbrookii holbrookii* (eastern spadefoot). Herpetological Review 32 (1): 56.

Tietz, H. M. 1972. An index to the described life histories, early stages and hosts of the macrolepidoptera of the continental United States and Canada. 2 volumes. Allyn Museum of Entomology, Sarasota, Florida. 1041 pages.

Treacy, E. D. 1953. Birds of the Albany County pine-oak barrens. Kingbird 3: 84–86.

Tryon, R. M. and A. F. Tryon. 1982. Ferns and allied plants, with special reference to tropical America. Springer-Verlag, New York.

Tuskes, P. M., J. P. Tuttle, and M. M. Collins. 1996. The wild silk moths of North America. Cornell University Press, Ithaca, New York.

U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. 2000. Fire Effects Information System [online]. Available: http://www.fs.fed.us/database/feis/

Uttal, L. J. 1987. The genus *Vaccinium* L. (Ericaceae) in Virginia. Castanea 52 (4): 231–255.

Van der Donck, A. 1968. A description of the New Netherlands (T. F. O'Donnell, ed.). Syracuse University Press, Syracuse, New York.

Voss, M. A. and J. S. Turner. 1996. Nest ventilation in the Allegheny mound-building ant (*Formica exsectoides*). New York Natural History Conference Abstracts (New York State Museum) 4: 18.

Weber, B. 1992. Effects of cutting and burning on the growth of scrub oak (*Quercus ilicifolia*) in the Albany Pine Bush. New York Natural History Conference Abstracts (New York State Museum) 2: 73.

Wheeler, A. G., Jr. 1991. Plant bugs of *Quercus ilicifolia*: myriads of myrids (Heteroptera) in pitch pine–scrub oak barrens. Journal of the New York Entomological Society 99 (3): 405–440.

Wheeler, A. G. and S. W. Wilson. 1996. Planthoppers of pitch pine and scrub oak in pine barrens communities (Homoptera: Fulgoroidea). Proceedings of the Entomological Society of Washington 98 (1): 100–108.

Whelan, R. J. 1995. The ecology of fire. Cambridge University Press. 346 pages.

Whitaker, J. O., Jr. and W. J. Hamilton, Jr. 1998. Mammals of the eastern United States, 3rd edition. Cornell University Press (Comstock Publishing Associates), Ithaca, New York. 583 pages.

Whittaker, R. H. 1979. Vegetation relationships of the Pine Barrens. Pages 315–331 in R. T. T. Forman (ed.), Pine Barrens: ecosystem and landscape. Academic Press, New York.

Whittaker, R. H. 1998. Vegetational relationships of the Pine Barrens. Pages 315–331 in R. T. T. Forman (ed.), Pine Barrens: ecosystem and landscape (revised edition). Rutgers University Press, New Brunswick, New Jersey. 601 pages.

Wood, D. M. and R. del Morel. 1988. Colonizing plants on the Pumice Plaines, Mount St. Helens, Washington. American Journal of Botany 75 (8): 1228–1237.

Wright, A. H. and A. A. Wright. 1949. Handbook of frogs and toads of the United States and Canada. Comstock Publishing Company, Ithaca, New York.

Yanega, D. 1996. Field guide to northeastern longhorned beetles (Coleoptera: Cerambycidae). Illinois Natural History Survey Manual 6: 1–174.

Zantopp, K. A. 2000. History of land use and protection in the Albany Pine Bush. Master's thesis, State University of New York at Albany. 122 pages.

MERTZ LIBRARY
NEW YORK
BOTANICAL
GARDEN

# Trailheads in the Albany Pine Bush Preserve

### 1 *Karner Barrens East and West*

East: Accessed from New Karner Road. This area is popular with new visitors to the Pine Bush. Several miles of trails meander through dunes and some of the best pitch pine-scrub oak barrens in the Preserve. The "overlook dune" along the Blue trail provides views of the Helderberg Mountains to the west and the Berkshire Mountains to the east.
Red trail - 1.7 mi., Blue trail - 0.8 mi., Yellow trail - 1.2 mi.

West: Accessed from Karner Barrens East by the White trail leading under New Karner Road just north of the Thruway. This area includes scenic forests and pitch pine-scrub oak barrens. Abandoned historic roads are part of the trail system.
Red trail - 0.6 mi., Blue trail - 0.8 mi.

### 2 *Rapp Barrens*

Accessed from Rapp Road. Within a short distance of the road, the trail crosses Patroon Creek. Skunk cabbage, false hellebore, and marsh marigold are a few of the plants that prefer this marshy, streamside habitat. The Red trail beyond the creek leads to hardwood forests, barrens, and views of Rensselaer Lake. Red trail - 1.2 mi.

### 3 *Rensselaer Lake Preserve and Park*

Accessed from Fuller Road. This eastern end of the Albany Pine Bush Preserve provides picnic and fishing facilities. A short connector trail along the lake edge provides access to the hardwood forests, barrens, and streamside habitats of the Rapp Barrens west of the Northway. White connector trail - 0.4 mi., Red trail, 1.2 mi.

### 4 *Blueberry Hill East*

Accessed from Columbia Circle, off Washington Avenue Extension. This disturbed portion of the Preserve was almost lost to economic development. Trails wind through sites that are being managed intensively; eventually they will be restored to pine barrens. Blue trail - 0.8 mi., Yellow trail - 0.9 mi.

### 5 *Blueberry Hill West*

Accessed from Pitch Pine Road, off the Washington Avenue Extension frontage road. This scenic area offers a diversity of topography and vegetation, and it features an appealing dune-top view to the south and the west. Inland barrens buck moths can be seen flying in late September or early October. Red trail - 1.1 mi.

### 6 *Kaikout Kill Barrens*

Accessed from the western end of the Washington Avenue Extension frontage road. This diverse area embraces dense pine barrens, rolling dunes, and a large, steep portion of the Kaikout Kill ravine that provides water to the Kaikout Kill west of New Karner Road. Blue trail - 1.2 mi.

### 7 *Madison Avenue Pinelands*

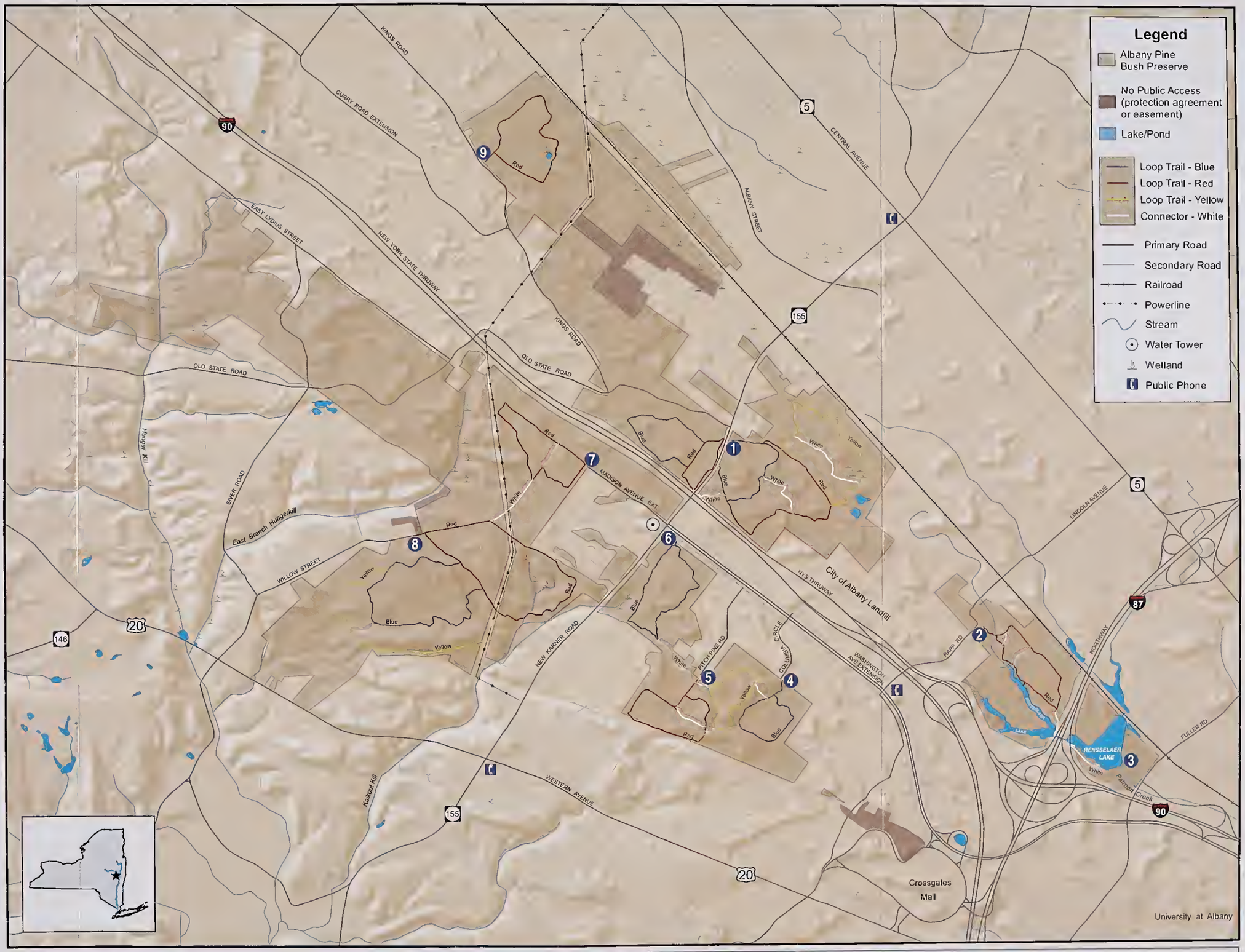
Accessed from Madison Avenue Extension, at the western end of Washington Avenue Extension. Throughout this area, dense forests of pitch pine trees contrast with open barrens. Wide, sandy trails provide easy hiking and skiing over rolling dunes. Wild blue lupine, the exclusive food plant of endangered Karner blue butterfly caterpillars, can be seen blooming in some open portions of this area in May and June.
Red trail - 1.2 mi.

### 8 *Great Dune*

Accessed from the east end of Willow Street. Great Dune is over a mile long and reaches up to 50 feet high. Diverse forest communities and pine barrens in this area adorn the rolling dunes, while dense masses of ferns and other moisture-loving plants blanket the steep slopes and damp floor of the Kaikout Kill ravine. Red trail - 1.8 mi., Blue trail - 1.4 mi., Yellow trail - 1.3 mi.

### 9 *Kings Highway Barrens*

Accessed from Kings Road, northwest of Curry Road Extension. A loop trail allows visitors to enjoy the forests and rare vernal ponds found in this region. The historic Kings Highway, which linked Albany and Schenectady, is adjacent to this area.
Red trail - 1.0 mi.




ALBANY PINE BUSH PRESERVE COMMISSION

NEW YORK State Museum

*The New York State Biodiversity Research Institute*

0.5 0.25 0 0.5 1 Kilometers

0.5 0.25 0 0.5 1 Miles

N W E S

Map produced November 2003. Published by the New York State Museum, Bulletin 502.
Preserve boundaries from the Albany Pine Bush Preserve Commission as of November 2001.

The New York State Museum is a program of
The University of the State of New York
The State Education Department